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ANALYTICAL REVIEW: A COMPARISON OF  
PROCEDURES AND TECHNIQUES  
USED IN AUDITING

by

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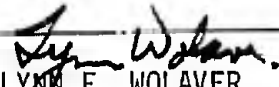
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ABSTRACT

This study compares some of the analytical review procedures which are currently used by practicing auditors. The comparison is based on the measured efficiency and effectiveness of the analytical review procedures applied to actual financial data. The measure of efficiency is the type I error rate and the measure of effectiveness is the type II error rate.

A simulation process is used to measure the type I and type II error rates of the alternative analytical review procedures. The analytical review procedures evaluated in the study are derived from information assessed from practicing auditors. This information includes: (a) the form of analytic techniques which are commonly applied by auditors, (b) the financial relationships to which the analytic techniques are applied, and (c) the decision rules which are applied to determine if identified fluctuations are significant.

Personal interviews are conducted with each participating auditor to derive the needed information. The results of the interview are summarized and returned to the participants for corroboration. There is consensus among the auditors concerning the form of analytical review procedures typically applied during an audit.

The simulation process applies each of the analytical review procedures to actual financial data seeded with monetary errors of various size and various monthly distributions across the account

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balances. Information concerning the nature of monetary errors is also assessed from practicing auditors. This information includes: (a) the likelihood that a potential source of monetary error will cause a material error in the financial account balances, (b) the possible distributions of the resulting material monetary error across the monthly account balances, and (c) the largest expected size of the resulting monetary error.

The results of the simulation identify specific analytical review procedures which are considered most efficient for a specified level of effectiveness. These procedures are incorporated into selection guidelines. The selection guidelines depict the associations between the 33 sources of monetary error most likely to result in a material error and the analytical review procedures which may detect that material error.

The major finding of this study is that the precision currently used with analytical review procedures may be too restrictive. Many investigations are signalled by the analytical review procedures as a result of normal fluctuations in the financial data, prior to the introduction of monetary error into the account balances. The results of the study suggest that analytical review procedures may not provide sufficient audit assurance when applied as substantive tests.

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## CHAPTER I

### INTRODUCTION TO THE STUDY

#### Problem Motivating the Study

Analytical review procedures are typically applied within the auditing context for six purposes: (a) understanding the nature of the client's business, (b) attention directing at the planning stage, (c) substantive testing, as a substitute for tests of details of transactions and balances, (d) attention directing during the final review process, (e) attention directing during interim audits, and (f) attention directing and substantive testing during compilations and review.

Analytical review procedures applied to enhance and maintain the auditor's understanding of the client's business should enable evaluation of management's performance in generating profitable operations and optimizing capital structure and determination of the current and future financial health of the enterprise.

When applied for the purpose of attention directing, the analytical review procedure should lead the auditor to perform or increase the extent of substantive tests whenever material errors exist in the related accounts.

When applied as a substantive test, the analytical review procedure should indicate the level of error (or absence of error) in the related accounts. The probability of detecting a material

error should be the same as a comparably reliable test of details. When analytical review is not used as a complete substitute, but in combination with detailed tests, the reduction in overall reliability resulting from the reduced detailed tests should be at least obtained by the analytical review procedure.

In all of the above situations, the basic question to be answered is:

How effective are analytical review procedures?

#### Purpose of the Study

Analytical review procedures have received attention in both professional and academic literature in auditing. The analytical review procedures currently in use are diverse in nature, ranging from informal scanning and comparison to structural models of particular accounts. According to Arens and Loebbecke, analytical review procedures are used extensively in all audits because they are a cost effective means of uncovering errors in financial data. They suggest that the following factors have motivated auditing researchers to seek more effective analytical review procedures:<sup>1</sup>

- a. The need to perform more efficient audits, necessitating the use of procedures that provide useful audit evidence at a low cost.
- b. Increased emphasis on understanding the nature of the client's business.
- c. A tendency to incorporate quantitative techniques in the audit process.

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<sup>1</sup>Alvin A. Arens and James K. Loebbecke, Applications of Statistical Sampling to Auditing (Englewood Cliffs: Prentice-Hall, 1981), pp. 313-14.

d. The requirement to perform formal reviews of published interim financial statements for publicly held clients.

e. Extension of accounting services to include compilation and review of financial statements for nonpublic entities.

Two recent surveys also suggest that analytical review procedures are receiving increased emphasis. McAllister, McAllister and Redding [1981] surveyed 113 practicing CPAs, and assessed their perceptions of the importance of analytical review procedures. The results of this survey indicate that most auditors perceive analytical review procedures to be a significant part of the audit process. The authors also found a significant variation across industries in the importance of analytical review procedures.<sup>2</sup>

Hylas and Ashton [1981] performed an empirical study of 281 errors requiring financial statement adjustments on 152 audits. Analytical review procedures applied during these audits detected 27.1 percent of these errors. Furthermore, analytical review was found to be as effective for signalling the smallest errors as it was for signalling the largest errors.<sup>3</sup>

These results suggest that analytical review procedures are perceived as being an important part of the audit process and are currently used by auditors. Yet research comparing the effectiveness of the alternative analytical review techniques<sup>4</sup>

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<sup>2</sup>John P. McAllister, Brian C. McAllister, and Rodney J. Redding, "The Importance of Analytical Review Procedures: A Survey," (University of Utah, n.d.), p. 6.

<sup>3</sup>Robert E. Hylas and Robert H. Ashton, "Audit Detection of Financial Statement Errors," (New York University, November 1980), p. 9.

has been limited, emphasizing the implementation and comparison of specific techniques within a specific auditing context. Such research has contributed to understanding the nature of these analytical review techniques, but the results of this research may not be valid outside of the specific auditing contexts used.

Thus, it is not possible to develop valid comparisons of the efficiency and effectiveness of the various analytical review techniques, or to contrast the performance of such analytical techniques with comparable detailed tests. Without such comparisons, it may not be possible to accurately assess the risks associated with the use of analytical review procedures. This, in turn, may reduce the application of appropriate techniques resulting in higher audit costs, or it may increase the audit risk beyond an acceptable level through the use of an inappropriate technique.

The purpose of this study is to provide evidence which may contribute to improved use of analytical review procedures in audits. The results of this study will aid auditors in the selection of analytical review procedures. The relative performance of alternative analytical review procedures will be examined, with explicit consideration given to the audit environment and the effectiveness of the procedures available for use.

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<sup>4</sup>The distinction between "technique" and "procedure" is as follows: An auditing procedure is an action performed to gather evidential matter. In an analytical procedure, the action is analytical in form and typically involves analysis of the interrelationships between financial data. Thus, a procedure is the combination of action and audit evidence gathered. A technique is the basic method used with the procedure. For example, the ratio technique might be used with the procedure of examining the relationship of cost of sales to sales for each product and month during the year.

### Overview of Research Approach

A simulation model is developed to evaluate the effectiveness of alternative analytical review procedures, based on the type I and type II error rates. The simulation process seeds audited financial data with various monetary errors. Alternative analytical procedures applied to various months within the seeded data sets generate decisions to investigate or not investigate fluctuations in the monthly financial data. Since it is assumed that there are no material errors in the audited financial data, a correct decision to investigate occurs only when material monetary errors are seeded into the month being investigated. Likewise, a correct decision to not investigate occurs only when no material errors are seeded into the month being investigated.

If an analytical procedure signals investigation, but no material errors are seeded, then there is an incorrect decision to investigate (type I error). If an analytical procedure does not signal an investigation when material errors are seeded, then there is an incorrect decision to not investigate (type II error). The type I error rate for an analytical procedure is derived by dividing the total number of type I errors by the number of months investigated by that analytical procedure. For example, if an analytical procedure applied to ten months resulted in five type I errors, the type I error rate would be fifty percent. The type II error rate is computed in the same manner.

The control parameters for the simulation process are the size and distribution of the monetary error and the alternative analytical procedures. The information needed to define the composition of these parameters was not readily available in the auditing literature. Thus, empirical research was required.

The needed information was derived from practicing auditors using a modified-Delphi method. Personal interviews were used to collect initial estimates on the nature of analytical review procedures and monetary errors. For analytical review procedures, the participants provided information on the type of analytical review technique typically applied during an audit, the financial relationships to which they are applied, and the decision rules used to identify significant fluctuations for investigation. The participants also provided estimates of the likelihood of a potential source of monetary error resulting in a material error in the financial statement balances, the distribution of the resulting error across the monthly balances, and the largest expected size of the error.

The results of the initial interviews were summarized and returned to the participants as feedback in the form of a questionnaire. Responses to the questionnaire provided follow-up estimates to corroborate the results of the initial interviews. These corroborated results were used to establish the various levels of control for the simulation model.

The audited financial data used during the simulation process was provided by two firms considered "representative" of the specified industry by practicing auditors. Each firm provided two overlapping four-year sets of monthly financial data, 1976 to 1980 and 1977 to 1981.

The results of the comparative analysis of alternative analytical procedures are used to produce selection guidelines for auditors. These guidelines relate the analytical procedure (defined as an analytical technique, financial relationship, and decision rule) to the potential sources of monetary error. Errors

which result from the potential sources affect the financial accounts evaluated by the analytical procedure. For the specified sources of monetary error, the guidelines allow the auditor to select the most efficient analytical procedure which provides a specified level of effectiveness.

#### Selection of Industry and Subject Firms

The manufacturing industry was selected as the foundation for designing the research approach. The objective of a manufacturer is to use resources to produce a product that can be sold at a profit. To achieve this objective, raw materials are acquired and processed to convert them into finished products that are delivered to customers. The activities of a manufacturer tend to be more extensive than firms in other industries, and include manufacturing or production, marketing and selling, and general and administrative functions. Comparative studies of statistical estimators by Neter and Loebbecke [1975] and of analytical techniques by Kinney [1979b] have relied on data from manufacturing firms.<sup>5</sup>

Both the type of business activity and the size of the enterprise usually affect the analytical procedures applied during an audit. The selection of medium-sized manufacturing firms should provide relative homogeneity of accounting events. A medium-sized firm provides an expectation of reasonably adequate internal accounting control while excluding large firms which have highly

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<sup>5</sup>John Neter and James K. Loebbecke, Behavior of Major Statistical Estimators in Sampling Accounting Populations (New York: American Institute of Certified Public Accounts, 1975), pp. 11-29; and William R. Kinney, Jr., "The Predictive Power of Limited Information in Preliminary Analytical Review: An Empirical Study," Journal of Accounting Research 17 (Supplement 1979):148-65.

individualized accounting systems and audit problems. However, there is not a standard definition of "medium-sized."

Kinney [1979b] used a range of \$5-10 million in annual sales to define small manufacturing firms.<sup>6</sup> Using this definition for small firms, \$10 million in annual sales becomes the lower bound for medium-sized manufacturing firms. The value for the upper bound within this study is set at \$200 million in annual sales. This upper bound was established after conversations with some of the practicing auditors who participated in the study. The firms which provided financial data for this study have annual sales in the range of \$15 to 30 million.

#### Nature of Analytical Review Procedures

##### Use of analytical review

Analytical review procedures have been proposed for use in understanding the nature of the client's business, in directing attention to accounts requiring further investigation and as substitutes for tests of details.

Understanding the client's business. Auditing standards dictate that: "The auditor should obtain a knowledge of matters that relate to the nature of the entity's business, its organization, and its operating characteristics."<sup>7</sup> Both professional and academic literature suggests that analytical procedures are commonly applied by auditors to gain insight to the

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<sup>6</sup>Kinney, "Predictive Power of Limited Information," p. 154.

<sup>7</sup>American Institute of Certified Public Accountants, Codification of Statements on Auditing Standards (Chicago: Commerce Clearing House, 1981), sec. 311.07.

client's business and its operating characteristics.<sup>8</sup>

When applied to understand a client's business and its operating characteristics, analytical review procedures are directed toward solvency and profitability. An analysis of solvency should allow the auditor to assess the ability of the enterprise to meet its financial obligations as they come due. Analytical review procedures applied to evaluate the profitability of a client should allow the auditor to appraise management's performance in generating profitable operations and in optimizing capital structure.

Attention directing. Using analytical review procedures for attention directing involves predicting or identifying the need for other auditing procedures. The need for additional audit procedures are typically identified by fluctuations, which result from large differences between the book and expected values.

According to Kinney, fluctuations can be caused by:

- a. The presence of accounting error.
- b. The presence of an irregularity.
- c. A change in accounting principle.
- d. A change in business conditions.
- e. Unusual events.<sup>9</sup>

Auditing Standards dictate that:

The auditor should investigate fluctuations that are not expected, the absence of fluctuations that are expected, and other items that appear to be unusual that are identified by analytical review procedures when he believes that those fluctuations or unusual items are indicative of matters that have a significant effect on this examination.

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<sup>8</sup>Alvin A. Arens and James K. Loebbecke, Auditing: An Integrated Approach (Englewood Cliffs: Prentice Hall, 1980), p. 187; and Touche Ross & Co., Financial Analysis as an Audit Tool (New York: Touche Ross & Co., 1978), p. 1.

<sup>9</sup>Kinney, "Predictive Power of Limited Information," p. 150.

In deciding the nature and extent of procedures which should be used to investigate significant fluctuations, the auditor's consideration should include the following factors:

- a. The objective of the analytical review procedures.
- b. The nature of the item.
- c. The auditor's knowledge of the entity's business.
- d. The results of other auditing procedures.
- e. The auditor's study and evaluation of internal accounting control.<sup>10</sup>

Albrecht [1979] outlines the following procedures for applying analytical review techniques with the objective of attention directing:<sup>11</sup>

- a. Predict what the account balances would have been if past trends, structural relationships, etc, were to continue into the future. This is supported by Auditing Standards which cite:

A basic premise underlying the application of analytical review procedures is that relationships among data may reasonably be expected by the auditor to exist and continue in the absence of known conditions to the contrary.<sup>12</sup>

- b. Compute the difference between the reported values and the projected values.
- c. Determine the statistical significance of this difference. Differences may result from the use of analytical review techniques, and may not represent actual fluctuations in the account balances. Thus, the effectiveness and efficiency of the analytical review technique must also be considered in determining significance.
- d. Determine whether further audit actions are

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<sup>10</sup>AICPA, Codification, sec. 318.08-09.

<sup>11</sup>Wm. Steve Albrecht, "Toward Better and More Efficient Audits," Journal of Accountancy, December 1979, p. 49.

<sup>12</sup>AICPA, Codification, sec. 318.03.

appropriate, which includes: (1) inquiries of management, (2) extensions of the analytic model, if appropriate based on managements response, and (3) returning to step (a) and repeating the process.

Kinney and Felix [1977] note that there is little controversy with using attention directing techniques as audit procedures. Their analysis suggests that the use of attention directing techniques will increase type I errors, while reducing type II errors.<sup>13</sup>

Test of details substitute. According to the Auditing Standards, analytical review procedures may be applied as substantive tests:

The evidential matter required by the third standard is obtained through two general classes of auditing procedures: (a) tests of details of transactions and balances and (b) analytical review procedures applied to financial information.<sup>14</sup>

Variations in the auditor's reliance on substantive tests may arise from differences in circumstances bearing on the expected effectiveness and efficiency of the respective procedures. Effectiveness refers to the audit satisfaction that can be obtained from the procedures, while efficiency refers to the audit time and effort required to perform the procedures. According to Arens and Loebbecke, analytical tests do not require a great deal of time to perform.<sup>15</sup> This suggests that analytical tests tend to be more

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<sup>13</sup>William R. Kinney, Jr. and William L. Felix, Jr., "Analytical Review Procedures," Journal of Accountancy, December 1977, p. 49.

<sup>14</sup>Ibid., sec. 320.70. In sec. 230.01, the third general standard is defined as: "Due professional care is be exercised in the performance of the examination and the preparation of the report."

<sup>15</sup>Arens and Loebbecke, Statistical Sampling, p. 314.

efficient than tests of details and transactions. The necessity to improve audit productivity (maintaining the same effectiveness while increasing efficiency) implies that an unavoidable shift must occur within the audit process from detailed tests to analytical review.

With respect to substantive tests, application of analytical review procedures may lead to the following conclusions.

a. If no unreasonable relationships are identified, and the procedure provides the required degree of reliability, then the auditor may rely on the results of the analytic test in forming the audit opinion.

b. If unreasonable relationships are identified, then the analytic test has in essence become attention directing. Additional analytic tests may be conducted to isolate the unusual fluctuations. However, such procedures may not be sufficient to identify the cause of the fluctuations, and detailed tests may be required. The results of the analytic tests may allow reduction of the extent of the detailed tests.

Applying the criteria established in Auditing Standards, the selection of analytical review procedures as substantive tests depends not only on the objective of the procedure identifying the fluctuation for investigation, but also the nature of the item being investigated, the auditor's knowledge of the client's business, and the reliance on internal accounting control.<sup>16</sup>

With respect to the reliability of using analytical review as a substitute for detailed substantive testing, Kinney and Felix [1977] suggest that use of analytical review procedures may decrease the likelihood of type I errors, while increasing the

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<sup>16</sup>AICPA, Codification, sec. 318.08-09.

likelihood of type II errors (the opposite effect of when used for attention directing).<sup>17</sup> In most audit situations this is an undesirable result. It therefore becomes important for an auditor to understand the effectiveness of the analytical review procedure as compared to the effectiveness of the comparable detailed tests. The main difficulties in comparing detailed tests with analytic tests relate to quantifying or demonstrating the reliability of the analytical review procedure.

#### Effectiveness of analytical review

When statistical procedures are employed, effectiveness is typically measured in terms of "precision" and "reliability." Precision expresses the range or limits within which the sample result is expected to be accurate, while reliability expresses the mathematical probability of achieving that degree of accuracy. One way to adapt measurements of precision and reliability to the auditor's purposes is by relating precision to materiality and reliability to the reasonableness of the basis for the audit opinion.

Evaluation of the precision in monetary terms contributes directly to the determination of a "reasonable basis for an opinion," which is comprehended in the third standard of field work. The auditor's decision as to the monetary amount that would be considered material should be based on judgement in the circumstances of the particular case.

Relating reliability to the reasonableness of the basis for an opinion implies a certain degree of inherent uncertainty. This uncertainty resulting from the application of audit procedures is

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<sup>17</sup>Kinney and Felix, p. 99.

referred to as "ultimate risk." SAS 39 defines ultimate risk as a combination of the risk that material errors will occur in the accounting process used to develop the financial statements and the risk that any material errors that occur will not be detected.<sup>18</sup> The first risk is typically reduced by reliance on internal accounting controls, while the second risk is reduced through the use of substantive tests.

SAS 39 defines two aspects to ultimate risk; sampling risk and nonsampling risk. Sampling risk arises from the possibility that the auditors conclusions which are based on sample results may be different than conclusions which are based on examination of the entire population. Nonsampling risk includes all the aspects of ultimate risk that are not due to sampling, including the possibility of selecting inappropriate auditing procedures or failing to recognize errors in the data examined.<sup>19</sup>

There are two types of sampling risk which relate to the performance of substantive tests:

a. The risk of incorrect acceptance (type II errors). This is the risk that the results of the test support the conclusion that the recorded account balance is not materially misstated when it is materially misstated. This risk relates to the effectiveness of an audit procedure in detecting an existing material misstatement.

b. The risk of incorrect rejection (type I errors). This is the risk that the results of the audit procedure supports the conclusion that the recorded account balance is materially misstated when it is not. The risk of incorrect rejection relates

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<sup>18</sup>AICPA, "Audit Sampling," Statement on Auditing Standards 39 (New York: AICPA, 1981), p. 3.

<sup>19</sup>Ibid., para. 9-11.

to the efficiency of the sample size. The initial erroneous conclusion of a material misstatement results in the application of additional audit procedures. The consideration of the additional audit evidence should lead the auditor to the correct decision.

There does not appear to be any evidence of the effect on ultimate risk of using analytical review techniques as opposed to substantive tests of details. Analytical review procedures focus on the reasonableness of the reported balances while substantive tests of details focus on individual transactions comprising the reported balances. The analytical techniques identify the existence of seemingly unreasonable relationships, but may not identify the cause of the unreasonable relationship. Thus, an analytical review procedure, by itself, may not provide the extensive verification needed to validate potential misstatements in the account balances.

#### Types of analytical review methods

Analytical review involves the study and comparison of trends and relationships among items (a) within a single year's financial statements, (b) in a succession of financial statements, and (c) with other business enterprises. Implicit in the use of analytical review are expectations of what recorded amounts should be and what variation or range of possible values might reasonably be expected. The method by which these expectations are generated can be used to categorize the analytic techniques. This form of categorization also facilitates analysis since the statistical assumptions for the analytic techniques are contingent on the method of deriving the expectation. The following categorizations result: (a) subjective evaluation by experienced auditors, (b) traditional analytic methods, including commonly used techniques such as ratio analysis and time trend analysis, and (c) structural models.

Subjective evaluation by experienced auditors. Subjective evaluation occurs when experienced auditors use their knowledge of a client's business and past audit experience to formulate a judgement on the reasonableness of the financial statement data. This form of evaluation is termed a "reasonableness test." The approach assumes that experienced auditors can make effective evaluations. Literature concerning subjective evaluations within an audit context indicates that large individual differences between auditor judgements do occur. The existence of heuristics in auditor judgements accounts for some of these differences, but not all of them. Also, the conclusions reached by subjective evaluation may not be replicated.<sup>20</sup>

Subjective evaluation may be applied in understanding the nature of the client's business or as an attention directing technique. For example, the auditor may indirectly incorporate knowledge of economic trends in forming expectations of performance or in estimating account balances. Auditing standards allow substantive tests of details to be applied on a subjective basis. However, the auditor may not be able to substantiate that an analytical review procedure based on a reasonableness test provided the same level of effectiveness as that provided by a substantive test of details.<sup>21</sup>

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<sup>20</sup>Robert H. Ashton, "An Experimental Study of Internal Control Judgements," Journal of Accounting Research 12 (Spring 1974):143-57; Edward J. Joyce and Gary C. Biddle, "Are Auditors' Judgements Sufficiently Regressive," Journal of Accounting Research 19 (Autumn 1981):323-49; William R. Kinney, Jr. and Wilfred C. Uecker, "Mitigating the Consequences of Anchoring in Auditor Judgements," The Accounting Review 57 (January 1982):55-69; and Wilfred C. Uecker and William R. Kinney, Jr., "Judgemental Evaluation of Sample Results: A Study of the Type and Severity of Errors Made by Practicing CPAs," Accounting, Organizations, and Society 2 (1977):269-75.

<sup>21</sup>AICPA, Codification, sec. 520.75 and 320B.31.

Traditional analytic methods. Ratio analysis involves the use of simple quantitative relationships to provide proportional comparisons. A ratio calculation is used to derive the estimated ratio value for the current audit period. The auditor's expectation is that this estimated ratio value equals the ratio value of last month, last year, or the average for the industry. In determining the allowable variation, one typically assumes that the structural relationships between accounts remain constant over time. Although this approach is fairly reliable and very inexpensive, its effectiveness is dependent on the decision rule used to evaluate the significance of fluctuations in the ratios.

Trend analysis procedures are used to predict what the current audit periods account balances should be if the account conforms to a predictable pattern. This assumes that the time series trend will continue into the future.

Trend analysis procedures do not allow the consideration of structural variables with the time trends. They are also subject to the bias of the auditor in determining the allowable variation. With respect to generating the expectation, research by Kaplan [1978] indicates that accounting series data cannot be predicted with great precision using the existing known models.<sup>22</sup>

Both academic and professional literature indicates that traditional analytic methods are applied to gain understanding of the client's business and to direct attention to significant fluctuations. Since the effectiveness of the traditional analytic methods can be quantitatively established, it is easier for the

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<sup>22</sup>Robert S. Kaplan, "Developing a Financial Planning Model for Analytical Review: A Feasibility Study," Symposium on Auditing Research III (Urbana, IL: University of Illinois, 1978), pp. 8-32.

auditor to substantiate their use as a replacement for substantive tests of details.

Structural models. Regression, Box-Jenkins and index models have been proposed for use as analytical review techniques to relate account balances to environmental variables. The objective of such structural models is to determine whether the fluctuation in account balances are due to material accounting error, correct balances under changed generating processes, or random disturbances.

The structural models differ fundamentally in the way in which past data is incorporated to generate the expectations. In regression, the conditional expectations are based on both past audited balances and the past and present structural data. In the basic Box-Jenkins model, only the past audited values for the account under audit are considered in forming the expectations.

The approaches also differ in the basic underlying assumptions. Regression examines the reasonableness of the expectation on the basis of both structural relationships between variables and past audited balances. The approach allows for multiple independent variables, exploration of non-linear relationships between the independent and dependent variables, and allows adaption to include seasonal parameters. But the regression approach assumes: (a) no change in the generating process, (b) no material accounting errors, (c) no correlations, (d) homoscedasticity, (e) no multicollinearity, (f) linearity between the dependent and independent variables, (g) normality, and (h) good internal control.

Box-Jenkins time series forecasts are based only on past history, or on past history in conjunction with a leading economic indicator. The approach is theoretically appropriate for data with

a time trend. It is also comprehensive, reduces the bias of the investigator, models dynamic relationships, and is relatively inexpensive once set up. However, the approach needs a minimum historical time series of thirty observations, and can handle only one independent variable.

Index models exploit cross-sectional commonalities in accounting numbers induced by the economy and industry factors. The basic underlying assumptions are: (a) zero expected value of the residuals, (b) constant residual variance, (c) zero cross-sectional covariance, (d) no autocorrelation in residuals, and (e) independence between residual term and independent variable indices.

The use of structural models allows explicit consideration of structural variables in conjunction with external and/or budgeted data. However, development of the appropriate model with the greatest predictive accuracy typically requires substantial training and experience. Although auditor bias is less of a problem in structural models, such bias may still exist during selection of variables to be included in the model, and may still influence the results.

Structural models are currently applied to assist the auditor in understanding the financial health of the client. Deloitte, Haskins and Sells use regression analysis as the basis for their Statistical Techniques for Analytical Review (STAR) program. According to Stringer [1975], the STAR program is applied for both attention directing and substantive testing.<sup>23</sup>

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<sup>23</sup>Edward I. Altman and Thomas P. McGough, "Evaluation of a Company as a Going Concern," Journal of Accountancy, December 1974, pp. 50-57; and Kenneth W. Stringer, "A Statistical Technique for Analytical Review," Journal of Accounting Research 13 (Supplement 1975): 4.

Selection of analytical review  
methods

The following issues should be considered when selecting among alternative analytical review techniques and procedures:

Approaches to model development. There are two basic approaches to building a structural model; developing a hypothesized model or using statistical selection techniques to identify the significant variables. Akresh and Wallace [1980] believe that the auditor's objectives imply that a hypothesized model should be taken as a given drawn from the auditor's knowledge of the client's business and past experience. Statistical techniques should be used to support the variables selected, rather than to search for the descriptor variables. Implications of the litigation environment and the auditor's objective of understanding as opposed to simply forecasting a client's operations suggest the impropriety of the auditor applying statistical selection procedures as the primary means of model development.<sup>24</sup>

Cost/benefit factors. Comparisons among alternative techniques should explicitly consider the following cost/benefit factors:

a. Computer costs. The computer time required to build and evaluate sophisticated structural models should exceed the time required to analyze simple financial relationships. It is assumed that comparable data files are required for all forms of computer analysis, such that the only incremental costs are

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<sup>24</sup>Abraham D. Akresh and Wanda A. Wallace, "The Application of Regression Analysis for Limited Review and Audit Planning," paper presented at the Symposium on Auditing Research IV, University of Illinois, 1980, p. 21.

associated with processing time.

b. Data base generation problems, both with respect to attainment of data and accuracy of data. The auditor must get the client to commit people for data gathering and model development activities.

c. Training to use the technique. Elliott [1978] asserts that training in regression to develop usable skill is time consuming and expensive. Valid modeling depends on meeting a number of technical assumptions that require considerable skill to evaluate. Also, model building requires a great deal of time, effort, and skill to reflect the underlying economic relationships.<sup>25</sup>

d. Low resolving power of some techniques. The issue is especially important during selection of techniques in light of the high standards of professional care and onerous legal burdens with substantial liability in the case of substandard work.

e. Technical validity of the approach. If preprogrammed packages of analytical techniques are available, there may exist a tendency to apply techniques that are not theoretically valid for the financial relationships being analyzed. Assume that an auditor is interested in analyzing administrative expenses over time. An example of an invalid technique would be to perform a horizontal analysis of administrative expenses to gross sales when it is not expected that administrative expenses would be related to gross sales.

f. Auditor loss functions. Many statistical sampling techniques incorporate the desired precision level with hypothesis

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<sup>25</sup>Robert K. Elliott, "Discussant's Response to "The Effect of Measurement Error on Regression Results in Analytical Review,"" Symposium on Auditing Research III (Urbana, IL: University of Illinois, 1978), p. 66.

testing. In such situations, auditor loss functions are implicitly assumed in specifying the significance levels for hypothesis testing. The cost of rejecting a correct account balance is the average loss from additional sampling and investigation costs. The cost of accepting an incorrect account balance is primarily the cost of liability losses and related penalties. These are related to the probability of a liability lawsuit given that the incorrect amounts are detected and are material, and the probability of losing such a lawsuit. A study of Class Action lawsuits by Kellogg [1978] indicates that court awarded damages are more frequent if reported values are ex post overstated rather than ex post understated.<sup>26</sup>

Most loss functions which have been investigated in the literature have been linear, step-functions, or quadratic. Regression models use the mean square of the error terms as the implicit loss function. Given that the form of the auditor's loss function has not been established, it may be inappropriate to assume that loss functions are similar. Additionally, there is no evidence to support the assumption that implied loss functions across structural models are similar.<sup>27</sup>

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<sup>26</sup>R. L. Kellogg, "An Empirical Study of Class Action Lawsuits by Buyers of Common Stocks Based Upon Accounting Errors," (University of Rochester, 1978)

<sup>27</sup>Barry E. Cushing, "Decision-Theoretic Estimation Methods in Accounting and Auditing," (University of Utah, 1980); William R. Scott, "Auditors' Loss Functions Implicit in Consumption-Investment Models," Journal of Accounting Research 13 (Supplement 1975):98-117; Wanda A. Wallace, The Economic Role of the Audit in Free and Regulated Markets (University of Rochester, 1980); and Bart H. Ward, "An Investigation of Auditors' Perceptions of the Severity of Error in Audited Financial Statements," Symposium on Auditing Research II (Urbana, IL: University of Illinois, 1976), pp. 23-29.

Factors affecting model validity. Factors affecting model validity are related to cost/benefit factors, but are somewhat different in that they may influence selection of procedures independent of cost/benefit considerations. They include:

a. Changes in the base period or audit period which make historical data no longer representative, e.g., major acquisition, divestiture, or change in the structure of the industry during the current audit period.

b. Measurement error, in either the dependent or independent variables. Spurious significance may occur due to measurement errors in the accounting data. The results may be mistakenly interpreted as more precise than is warranted due to impurities in the empirical data. Kinney and Bailey [1976] note that the use of external sources or internal audits may allow increased confidence.<sup>28</sup>

c. Adjustments in fiscal end-of-year month. Kaplan [1978] introduces the idea of excluding fiscal end-of-year months from the base period to alleviate problems associated with end-of-year adjustments. Kinney and Salamon [1978] advocate correcting all errors discovered in an audit before using the data for model development.<sup>29</sup>

d. Incentives for the client to misstate financial statements. An important aspect of the analytical review process concerns incentives by management and employees to misstate account

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<sup>28</sup>William R. Kinney, Jr. and Andrew D. Bailey, Jr., "Regression Analysis as a Means of Determining Audit Sample Size: A Comment," The Accounting Review 51 (April 1976):396-401.

<sup>29</sup>Kaplan, pp. 10-11; and William R. Kinney, Jr. and Gerald L. Salamon, "The Effect of Measurement Error on Regression Results in Analytical Review," Symposium on Auditing Research III (Urbana, IL: University of Illinois, 1978), p. 63.

balances. Incentives are provided in the form of profit sharing plans, performance evaluation measures, and bond covenant requirements. Such issues are relevant in determining the types of errors most likely to occur, the symmetry of expected errors, and whether intentional errors are most likely to be account or bottom-line directed.

e. The likelihood of type I and type II errors.

During audit planning, the acceptable levels of audit risk are established. If the error rate for an analytical review procedure exceeds the acceptable level of risk, then the auditor is not obtaining the planned audit assurance.

f. The size of base period to produce a viable model.

For regression based models, the base period must include at least thirty-six months of financial data for each financial account to be analyzed. Other structural techniques may require even larger base periods to produce models with high predictive ability and acceptable audit assurance.

g. The influence of structural variables not

explicitly considered. There is always the risk that significant relationships between the data are being caused by variables extraneous to the model. In such situations, the relationships identified by the model may be interpreted as being more precise than if the extraneous variables were correctly included in the model.

h. A failure to meet model assumptions. The

performance of some structural models can only be guaranteed under strict operating environments. For example, regression analysis assumes that the residual terms are random and independent. Yet, many financial accounts analyzed by regression procedures have serially correlated residuals. A failure to recognize this condition and apply the appropriate fix will invalidate the results

of the analysis. Thus, the assumptions of the model must be evaluated with respect to the nature of the financial data being analyzed.

i. A variance may be so large that precise assessment of accounting error cannot be achieved. Normal fluctuations in the monthly balances of the financial data may be so large that the analytical procedures signal investigations when material errors are not present. Hence, the type I error rate becomes so large that the analytical procedures do not provide any additional information to the auditor.

j. Auditor error in implementation of techniques, especially those requiring special auditor skills.

k. Auditor error in interpretation of results of the model. The more variables that are included in a model, the more difficult it becomes to interpret the relationships between those variables and their effects on the results. Thus, there may be a tradeoff between a simple model with lower predictive ability but interpretable results and a sophisticated model with high predictive ability but numerous interrelationships between predictor variables.

#### Summary

The goal of this chapter is to introduce the research topic. The major research question concerns the effectiveness of alternative analytical review procedures. Analytical review is defined, and some of the reasons for pursuing research in the area are presented.

The simulation process used in this study is briefly discussed. The simulation process is designed to measure the type I and type II error rates of the analytical review procedures applied to financial data sets. The financial data sets are

controlled with respect to the size and distribution of monetary error in the monthly financial account balances. A modified Delphi method is used to assess information from practicing auditors concerning the analytical review procedures evaluated and the characteristics of monetary errors.

Three potential applications of analytical review procedures are discussed: understanding the client's business, directing attention to large fluctuations for further investigation, and providing evidential matter as a substantive test. When analytical review procedures are applied for attention directing or as a substantive test, the auditor is primarily concerned with the effectiveness of the procedures.

The effectiveness of an analytical review procedure is measured in terms of precision and reliability. Precision is expressed in terms which relate to materiality. Reliability relates to the ultimate risk which results from applying analytical review procedures.

A discussion of the characteristics of analytical review procedures focused on subjective evaluation methods, traditional analysis methods, and structural models. For each category, the objectives, underlying assumptions, and potential applications are identified. Some of the methodological issues which should be considered when selecting and comparing alternative analytical review methods are discussed.

## CHAPTER II

### RELATED RESEARCH

#### Introduction

The purpose of this chapter is to integrate the results of existing research which is applicable to this research effort. The three sections of the chapter categorize the existing literature as to whether it pertains to analytical review procedures or the nature of accounting errors.

Published research concerning analytical review procedures in an auditing context may be classified into three distinct areas: development of financial planning models, comparisons of the various methods, and analysis of some of the methodological issues which arise when such methods are applied in practice. Basically, this first section of the chapter will show that no single analytical review technique works best in all auditing situations.

The second section will review the research conducted on the nature of errors within financial statement data. Although these studies did contribute to our understanding of possible financial statement errors, most are limited in that they only analyze errors which were detected within specific financial accounts during an audit. Hence, these studies provide error analysis for only a few financial accounts. Further, within those accounts which were analyzed, not all potential errors were detected.

## Analytical Review Procedures

### Development of financial planning models

Use of analytical review techniques may facilitate development of higher accuracy financial planning models for projecting financial statements. A financial planning model developed for a firm would allow projection of complete pro-forma income statements and balance sheets, based on historical relationships and contemporary economic conditions. According to Kaplan [1978], if such projected statements agree with those supplied by management, the auditor can have increased assurance about the overall reasonableness of the financial statements. However, for the auditor to obtain assurance from these projected financial statements, the important account balances must be estimated with high accuracy.<sup>1</sup> Thus, financial planning models used in an auditing context may require more precise estimates than those obtained from traditional financial planning models used for internal planning methods.

The purpose of Kaplan's study was to construct a financial model of a firm which can project complete pro-forma income statement and balance sheets based on historical relationships and contemporary economic conditions. The financial model was based on data from a large diversified industrial company.

The results of this study indicate that the existing prediction models are not always adequate for estimating financial account balances. Kaplan did find that the quarterly and annual

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<sup>1</sup>Kaplan, "Financial Planning Model," p. 4, suggests that estimation errors should be less than five percent.

forecasts came close to the actual statement balances. However, he recommends that the fiscal end-of-year months be excluded in regression analysis of monthly data since they may cause differing fluctuations in monthly measures across the years. He also found that certain account predictions decreased when aggregated across divisional forecasts.<sup>2</sup>

#### Comparisons of various analytic methods

Studies of auditor judgement. Blocher, Exposito, and Willingham [1982] performed a descriptive investigation of auditor judgements when planning for the use of analytical review and when applying an analytical review procedure to a given set of audit circumstances. Experimental cases were adapted from the audit workpapers of a medium-sized audit engagement. Forty-four audit supervisors and senior accountants of a single large audit firm were asked to develop a tailored audit program, describing any analytical review procedures they would use.

The authors observed a diversity in practice in the extent and use of analytical review procedures, both between and within CPA firms. Discussions with auditors suggested that some auditors are significantly more analytical in approach than others. This implies that only a few auditors might be considered experts in the use of analytical review.

The study is oriented toward investigating the apparent limited degree of consensus among auditors concerning the proper use and perceived potential effectiveness of analytical review. The dependent variables in the study were divided into planning and

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<sup>2</sup>Ibid., pp. 1-32.

usage categories. The planning category measures the planned scope of analytical review and detailed tests of transactions, and the auditors perception of the quality of audit evidence. The usage categories measure the type of analytical review procedure applied (none, ratio analysis, trend analysis, or reasonableness tests) and whether operating, industry, or economic data is used in the analytical review. The independent variables consisted of the scope of detailed tests in the prior year's audit program (high or low) and availability of a detailed checklist of suggested analytical review procedures.

The results show considerable variability concerning the allocation of budgets hours to analytical review relative to other substantive tests. An implication is that some auditors preferred an analytical approach while others preferred a test of details approach. Seventy-five percent of the participants chose trend analysis as the actual analytic technique applied, and only eighteen percent of the participants used the operating data in any significant way.

The audit program treatment did not have any significant effect on the planning variables. The authors suggest that the auditors chose to use a standard audit program rather than tailor the program for the audit environment provided. Providing an audit checklist for analytical review resulted in a planned higher scope for both analytic and detailed tests. For those auditors receiving the analytical review checklist, a significant positive association was found between the auditor's quantitative ability and the use of analytical review. This relationship was not observed for auditors not receiving the checklist. The use of reasonableness tests was also associated with the auditor's quantitative ability.

The authors conclude that auditors differ in their preference for audit tests, and they suggest that the quantitative ability of

the auditor may be associated with this individual preference.<sup>3</sup>

Kinney and Uecker [1982] investigated systematic bias in auditors' judgements resulting from anchoring and adjustment heuristics in two audit settings. Participants comprised 179 audit seniors from five of the Big Eight public accounting firms.

The first audit setting evaluated judgements concerning analytical review investigation rules. It was hypothesized that auditors assessing the reasonableness of current unaudited values would be anchored by these unaudited values. The participants were given two years of audited values and the current year unaudited values. Upper and lower precision limits (beyond which an investigation is signalled) were estimated from this information. To test the hypothesis, low and high current year unaudited values were given to two different groups. The auditors receiving the low unaudited values set the investigation boundaries significantly lower than the auditors receiving the high values. Those auditors receiving high values appeared less subject to anchoring.

The authors suggest that auditors should form expectations from past audited book values before examining the unaudited book values, thus avoiding the tendency to center subjective investigation intervals on the unaudited book values. Use of this technique assumes no material changes in the recent historical relationships of the financial data.

The second audit setting involved compliance sampling. Auditors employing the fractile assessment method were found to understate the achieved upper precision limit for the population error rate (committed type II errors) while auditors employing the

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<sup>3</sup>Edward Blocher, Robert S. Esposito, and John J. Willingham, "A Study of Auditor Judgements Concerning the Nature and Extent of Analytical Review in Auditing Payroll," (University of North Carolina, October 1981), pp. 1-19.

risk assessment method overstated the achieved risk that the population error rate exceeds the maximum allowable rate (committed type I errors). The authors suggest use of the risk assessment method to avoid some of the more severe consequences of excessive Type II errors.<sup>4</sup>

Studies of traditional methods. Kinney [1979b] studied the distributional characteristics of auditor-initiated adjustments and predictions of adjustments using summary workpaper balances and selected limited information analytical review procedures. His sample consisted of three years of data from forty four small manufacturing firms. The data were classified into twenty five accounts.

A measure of normal earnings was established using a three year average of audited net income. The materiality threshold, used as the operational measure, was set at ten percent of the normal earnings.

Four limited analytical review methods were evaluated: (a) the absolute difference in the balance of individual accounts from one year to the next, (b) the absolute difference in the balance of individual accounts relative to normal earnings, (c) an entropy measure of the proportion of each account to the total financial statement, and (d) the ratio of account balances. Various critical values were used for each method to determine when investigations are signalled. The methods were compared with respect to the percentage of incorrect signals to investigate when no material error was present in the accounts (type I error), and the percentage of incorrect signals to not investigate when materials errors were present in the account balances (type II

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<sup>4</sup>Kinney and Uecker, pp. 55-69.

error).

Kinney found audit adjustments of 10% or more of earnings in 24.5% of the accounts. The ratio of inventory to cost of sales, general and administrative expenses, and income tax related accounts were the most adjustment prone. Both the absolute difference relative to normal earnings and the entropy measures were found to focus on large changes in large accounts. Since the absolute difference measure is computationally simpler, it may serve as an inexpensive surrogate for entropy.

These results also indicate that the use of a simple rule-of-thumb which predicts an adjustment this year if there was a material adjustment last year compares well with other analytical techniques. This rule-of-thumb incorrectly signalled an investigation in 15.8% of cases where auditor initiated adjustments were not made, while not signalling an investigation in 33.7% of cases where auditor initiated adjustments were made.

Kinney concludes that the use of limited analytical review techniques using limited information tends to improve type-II error rates, but with an accompanying increase in the type-I error rates.<sup>5</sup>

In another study, Kinney [1981] investigated three prediction methods for forming an expectation of adjustments required to financial data: (a) comparison of a firm's book value ratio for the current year with the ratio based on the previous years audited values, (b) comparison of a firm's book value ratio for the current year with the industry average ratio, and (c) comparison of a firm's book values with an industry-based, bivariate contour of the audited values of the sample for the previous year. The sample

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<sup>5</sup>Kinney, "Predictive Ability of Limited Information," pp. 148-65.

consisted of three years of data from forty-four small manufacturing firms. The accounts investigated included accounts receivable, inventory, sales, cost of sales, and net income after tax.

The first two methods compared the ratio computed from the current year book value to the ratio computed from the summary audit workpapers of the previous years. Comparisons were based on a reasonableness range, defined as a 5, 10, or 15 percent change in the ratios. An investigation is signalled if the change in the ratio exceeded the reasonableness range.

The bivariate method plots the audited balances from the previous year for each account pair in two-dimensional space. The resulting contour map contains  $(1 - \alpha)$  percent of the audit value combinations under an assumed bivariate normal relationship. The probability levels were set at 0.20, 0.10, and 0.05. An investigation is signalled when a book value pair falls outside of the contour map.

A benchmark investigation rule is applied individually and in conjunction with each of the three methods. The benchmark rule signals an investigation for an account in the current year if adjustments were required in the previous year.

The two ratio methods were found to be relatively consistent with each other, yielding a reduction of at least one half in the type II errors present when using the benchmark alone. This also resulted in an accompanying increase of 3.5 to 7 times in the type I errors present. The bivariate method achieved a similar reduction in the type II errors, but with an increase of only 2.5 to 4 times in the type I errors. Although the bivariate method appears to outperform the ratio methods, it requires audited balances from all companies in the industry. This information is not presently available on a timely basis.<sup>6</sup>

Studies of structural methods. Deakin and Granof [1974]

investigated the use of regression analysis in hypothesis testing. Their sample included a retail chain of four stores. Using stepwise regression techniques, they constructed a regression model to evaluate cost of goods sold.

The authors conclude that regression techniques are a viable method for hypothesis testing. However, they suggest the use of a decision rule which is based on the difference between materiality and the absolute value of the reported amount minus the predicted amount. The alpha and beta risk for the decision rule should be calculated, and used either heuristically to investigate accounts with lower-than-acceptable confidence limits and higher-than-acceptable beta risks, or in a Bayesian revision of prior probabilities to determine the optimum sample size.<sup>7</sup>

Albrecht and McKeown [1976] sought to compare the degree to which regression, univariate Box-Jenkins, and bivariate Box-Jenkins techniques identify balances most appropriate for further investigation. Their sample includes thirty periods of data from unknown clients of Deloitte, Haskins & Sells (DHS). The accounts analyzed include circulation sales, paid circulation, raw material costs, hours worked, and wage index.

Regression, univariate Box-Jenkins, and bivariate Box-Jenkins models were developed for operating expense, revenue, and payroll expense accounts. The residual standard error was used to compare the degree to which the models fit the historical time series

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<sup>6</sup>William R. Kinney, Jr., "Predicting Auditor-Initiated Adjustments Using Paired Balance Methods," Journal of Accounting, Auditing, and Finance 21 (1981):5-17

<sup>7</sup>Edward B. Deakin and Michael H. Granof, "Regression as a Means of Determining Audit Sample Size," The Accounting Review 49 (October, 1974):764-71.

during the base period.

The results indicate that the bivariate Box-Jenkins technique performed best for operating expense and revenue accounts, while regression performed best for payroll expense. This leads to the conclusion that both regression and bivariate Box-Jenkins techniques are appropriate for performing statistical analytical reviews. This was contrary to their expectations that ratio analysis, trend analysis, univariate Box-Jenkins and regression analysis are subsumed under comprehensive bivariate Box-Jenkins analysis methods.<sup>8</sup>

Lev [1980] designed and empirically tested index-based prediction models for use in analytical review. The sample consisted of the annual sales, operating income, and net income for more than 500 firms from 14 industries obtained from the COMPUSTAT tape.

Lev used a submartingale process as a benchmark for comparison. Ball and Watts [1972] found that it is difficult to outperform the submartingale model for time-series data with large samples.<sup>9</sup> Mean prediction error was used as the basis for comparison.

The single index model was developed using Gross National Product and total corporate profits after tax. An industry index was incorporated to produce a double index model.

Lev found the predictive ability of the single index model superior to the benchmark. Use of a double index model, incorporating an industry factor, further improved the predictive

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<sup>8</sup>Wm. Steve Albrecht and James C. McKeown, "Toward an Extended Use of Statistical Analytical Reviews in the Audit," Symposium on Audit Research II (Urbana, IL: University of Illinois, 1976), pp. 53-69.

<sup>9</sup>Ray Ball and Ross Watts, "Some Time Series Properties of Accounting Income," Journal of Finance 27 (June 1972): 663-81.

ability.<sup>10</sup>

Kinney and Salamon [1981] compared alternative decision rules for regression analysis. The decision rules are used to indicate when additional audit investigations or extensions are necessary. The number of type I versus type II errors was used as the basis for comparison.

Coefficients reported from practical applications by Deloitte, Haskins & Sells (DHS) were used to construct 200 simulated audit years. The basic model was a simple linear regression. A 36 month base period and a 12 month current audit period were produced by generating dependent variables, independent variables, and residual error terms. A material accounting error was arbitrarily defined as two dollars or two percent of the expected audit balance of the account.

Eleven error conditions were examined: (1) no accounting error, (2-6) seedings in which the total error seeded was equal to a material amount, and (7-11) seedings in which the total error seeded was equal to 1.5 times a material amount. The multiple seedings consisted of one error at the total error size, two errors at one-half the total error size, four errors at one-fourth the total error size, six errors at one-sixth the total error size, and twelve errors at one-twelfth the total error size. All seedings were overstatement errors.

Three alternative decision rules were investigated. An annual balance approach was developed by Kinney [1979a] which assesses whether the accounting error in the balance for the audit year might exceed a material amount. This model looks at the cumulative balances for the audit year and should be unaffected by

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<sup>10</sup>Baruch Lev, "On the Use of Index Models in Analytical Reviews by Auditors," Journal of Accounting Research 18 (Autumn 1980):524-50.

the monthly distribution of the errors.<sup>11</sup> The second model incorporates a monthly filter to the first model. The monthly filter is applied to individual months in those audit years not signalled for investigation by the first model.

The comparison criterion for the monthly filter is proportioned according to the expected monthly distribution of the monetary errors. Incorporating the error distributions into the decision rule should maintain the overall effectiveness even against the most diverse distribution of errors over the monthly accounts. Assuming that the errors are evenly dispersed across the twelve months, one twelfth materiality is used as the comparison criteria.

The third model is based on the approach used by DHS. Upper precision limits are calculated on a monthly basis for various possible distributions of accounting error in the monthly account balances. The material amount used as the comparison criterion is also proportioned according to the monthly distribution of error.

The sensitivity of the DHS approach to various error distributions was analyzed. As the number of months containing errors increase, the materiality construct and the computed upper precision limit both decrease at a decreasing rate. However, the upper precision limit can go below zero. For sufficiently disperse error distributions, the materiality construct will always exceed the upper precision limit.

The simulation results indicate that the DHS approach was more effective when the total error seeded was equal to a material amount. When the total error was 1.5 times a material amount, the

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<sup>11</sup>William R. Kinney, Jr., "Integrating Audit Tests: Regression Analysis and Partitioned Dollar Unit Sampling," Journal of Accounting Research 17 (Autumn 1979):26.

DHS model produced a significantly higher number of type II errors for the more disperse error distributions. (For twelve errors, the annual type II error rate exceeded eighty percent.)<sup>12</sup>

Studies of traditional and structural methods. Kinney [1978] compared the predictive characteristics of ordinary least squares regression, integrated-autoregressive-moving-average (ARIMA), and martingale and submartingale techniques. His sample consisted of fifteen years of operating revenues of six railroads in the southwest region of the United States.

Regression models were built using the monthly railroad operating revenue series for the southwest region as the independent variable. Models included ordinary least squares, Cochrane-Orcutt, first differences, and first and seasonal differences. Models were estimated using both a 36 month base period and a 120 month base period. The regression assumptions of linearity, homogeneity of variances and normality did not seem to be violated. Positive autocorrelation was a problem for ordinary least squares, and the introduction of first or first and seasonal differencing induced negative autocorrelation. The Cochrane-Orcutt transformation appeared to work better than the other transformations.

The ARIMA models included an index model (regression using predictions of the independent variable in the audit period), a univariate Box-Jenkins, and a bivariate Box-Jenkins (transfer function). Naive models included the martingale and submartingale techniques.

Model comparisons were based on the bias of predictions

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<sup>12</sup>William R. Kinney, Jr. and Gerald L. Salamon, "Regression Analysis in Auditing: A Comparison of Alternative Investigation Rules," (University of Iowa, March 1981), pp. 1-26.

(smallest mean error) and the dispersion (smallest mean absolute error). The results indicate that models with the greatest information and computational requirements are superior in predictive power. A ranking of the models based on Kinney's results is presented in Table 1.<sup>13</sup>

Akresh and Wallace [1980] investigated the performance of regression analysis relative to traditional analytical review techniques in analyzing account variations during limited review engagements. The sample was a public utility with gas and electric operations.

During an actual limited review engagement, the audit team performed and documented traditional analytical review procedures. Upon completion of the review, the audit manager selected accounts for regression analysis, and a regression model was constructed. The results of the two methods were normatively compared.

The findings indicate that traditional analytical review procedures which focus on variation analysis will confirm the direction of the change, but not the magnitude. The regression approach provides both direction and magnitude estimates. The authors also assert that the regression approach decreases the amount of time for investigation and is more disciplined in its approach. The auditor is forced to think of relationships between variables, and to test the reasonableness and amount of fluctuations. This, in turn, requires an understanding of the nature of the business and sources of external and internal variables.<sup>14</sup>

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<sup>13</sup>William R. Kinney, Jr., "ARIMA and Regression in Analytical Review: An Empirical Test," The Accounting Review 53 (January 1978):48-60.

<sup>14</sup>Akresh and Wallace, pp. 1-42.

TABLE 1

## RANKED COMPARISONS OF ANALYTICAL REVIEW MODELS

Analytical Review Models	Comparison Criteria	
	Bias	Dispersion
Regression . . . . .	3	2
Index . . . . .	5	3
Univariate Box-Jenkins .	4	3
Bivariate Box-Jenkins .	1	1
Martingale . . . . .	6	6
Submartingale . . . . .	2	5

ADAPTED FROM: William R. Kinney, Jr., "ARIMA and Regression in Analytical Review: An Empirical Test," The Accounting Review 53 (January 1978):48-60.

Assessment of prior research. Investigations into the use of judgement in applying analytical review procedures detected a limited degree of consensus among auditors concerning the use of analytical review. Audit supervisors and senior accountants showed considerable variation in planning for the use of analytical procedures, yet they achieved apparent consensus on the use of analytical techniques. Trend analysis techniques were chosen by 75 percent of the participants.<sup>15</sup> This alleged consensus may result from the limited experience of the participants or the specific analytical training programs of the single CPA firm involved.

Anchoring heuristics were found to affect judgements concerning expected audit values. In an audit setting involving the use of analytical review procedures, audit seniors were asked to estimate a precision interval for a set of financial data. The precision interval was used to evaluate the reasonableness of the current periods unaudited book values. The results suggest that audit value expectations be formed prior to reviewing the current years unaudited book values.<sup>16</sup>

The remaining research activities were directed at comparisons of analytical review methods. The audited financial data used in these comparisons varied, including retail stores, railroads, small manufacturing firms, and a public utility. The specific accounts for which balances were estimated included operating revenue, operating expense, general and administrative expenses, inventory, operating income, and net income. The comparative advantage of one analytical review technique over

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<sup>15</sup>Blocher, et al., pp. 11-19.

<sup>16</sup>Kinney and Uecker, pp. 65-69.

another may not be valid within another industry or for different financial information.

One conjecture was that the bivariate Box-Jenkins technique encompassed the predictive characteristics of regression, univariate Box-Jenkins, and time trend techniques. This conjecture seemed to hold for those accounts which are highly dependent upon time series data, specifically operating expense and revenue accounts.

Albrecht and McKeown [1976] found that the bivariate Box-Jenkins model produced the best predictions of operating expense, using circulation sales and past operating expense as independent variables. Kaplan [1978] found that operating expense was a function of sales and a linear time trend. Although Kaplan did not specifically test the Box-Jenkins model, the functional dependencies suggest that the Box-Jenkins model would be most appropriate. Kaplan use a large diversified industrial company for his analysis while the actual clients' industry used in Albrecht and McKeown's analysis are not known.<sup>17</sup>

Albrecht and McKeown [1976] found that the bivariate Box-Jenkins model, using seasonal revenue and seasonal raw material costs as the independent variables, provided the best predictions for circulation sales. Kinney [1978] found that a bivariate Box-Jenkins model using seasonal autoregressive and moving average components provided the best prediction of monthly operating revenue for railroads.<sup>18</sup> Again, industry comparisons are not available.

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<sup>17</sup>Albrecht and McKeown, pp. 64-65; and Kaplan, "Financial Planning Models," pp. 9-10.

<sup>18</sup>Albrecht and McKeown, p. 65; and Kinney, "ARIMA and Regression," pp. 57-59.

It was also found that some account balances are more dependent on the structural relationships between accounts within the current period. Albrecht and McKeown [1976] used a regression model to predict payroll expenses as a function of hours worked, wage indices, and a seasonal constant. This regression model provided better predictions of the payroll expense than the bivariate Box-Jenkins model. Kinney [1979b] found that general and administrative expense accounts were the most adjustment prone in a sample of manufacturing firms.<sup>19</sup> The Box-Jenkins technique is based on historical relationships and leading economic indicators. If the economic indicators are not the source of the adjustments, then the Box-Jenkins technique would not provide accurate predictions.

The use of regression models does not exclude incorporation of time trend data. Time trends may be indirectly included when the independent variables are based on historical time sequences. Additionally, linear time trends and/or seasonal adjustments may be included. The advantage of regression over Box-Jenkins models is the ability to incorporate multiple independent variables. This is evident in the research by Akresh and Wallace. They achieved high prediction accuracy ( $R^2$  of 99.8) for revenue accounts of a public utility using multiple regression with various external, budgeted, and internal data as independent variables.<sup>20</sup>

Hence, one can conclude that no single analytical review technique will work best in all situations. In fact, the analysis by Kaplan [1978] reveals that structural models worked best in only three of the nine accounts investigated. Ratios performed best for

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<sup>19</sup>Albrecht and McKeown, p. 65; and Kinney, "Predictive Power of Limited Information," pp. 155-57.

<sup>20</sup>Akresh and Wallace, pp. 8-9.

cost of goods sold and depreciation, a time trend worked best for prepaid expenses, and random walks worked as well as other techniques for cash and inventory. It is also best to directly calculate interest expense as opposed to attempting prediction. This suggests that selection of prediction techniques is dependent on the characteristics of the prediction method and the nature of the account being analyzed.

Kinney and Salamon [1978] concentrated their efforts on comparing alternative decision rules which may be used with regression analysis. The results indicate that the decision rule developed by DHS was the most effective when the total amount of error in the accounts equals a material amount. All three decision rules were sensitive to the distribution of errors across the monthly accounts. As the error distributions became uniform across the monthly balances, the occurrence of type II errors increased.<sup>21</sup> If this sensitivity occurs in the decision rules for other analytical techniques, then prior knowledge of the potential error distributions may influence selection of the appropriate analytical technique.

Most of the traditional methods studied do not incorporate statistical models. In two studies by Kinney [1979b and 1981], traditional methods were compared on the basis of the type I and type II error rates. Various decision rules were used to determine when to investigate a fluctuation in the data. The decision rules generated a precision interval, which was based on some implied reliability level. Comparisons of alternative techniques assumes that the implied reliability levels in the decision rules are tantamount. Akresh and Wallace [1978] resorted to a normative

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<sup>21</sup>Kinney and Salamon, "Alternative Investigation Rules," pp. 1-27.

analysis to compare traditional and structural methods. But even this normative analysis must make some assumptions concerning the equivalence of reliability levels.<sup>22</sup>

Research concerning  
methodological issues

Traditional analytical methods. Lev and Sunder [1979] present a normative analysis of the conditions under which financial ratios achieve the intended objective of controlling for size. The authors assert that: "The major objective of using financial variables in the form of ratios is to control for the systematic effect of size on the examined variable."<sup>23</sup>

In cases where there is strict proportionality between the two variables, the objective of size control is achieved. However, deviations from strict proportionality may result in inadequate control for size, with the amount of bias varying with the size of the firm. Specifically:

a. With the presence of an additive error term ( $y=bx+e$ ), the control for size by the ratio is likely to be inadequate. In the presence of homoscedastic errors, the deviations from the slope are small for large firms and large for small firms. With heteroscedastic errors, two situations emerge: (1) if the error term has variance proportional to  $x^2$ , then each ratio has the same expectation and the same variance, implying adequate size control, and (2) if the error term variance is not

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<sup>22</sup>Kinney, "Predictive Ability of Limited Information," pp. 162-65; Kinney, "Paired Balance Methods," pp. 15-16; and Akresh and Wallace, pp. 14-17.

<sup>23</sup>Baruch Lev and Shyam Sunder, "Methodological Issues in the Use of Financial Ratios," Journal of Accounting and Economics 1 (1979):189

proportional to  $x^2$ , then size control is likely to be inadequate.

b. With the presence of a multiplicative error term which is non-negative ( $y=bx\epsilon$ ), and where the deviation of the ratio from the slope is not dependent on the size of  $x$ , then adequate control for size is achieved.

c. With the inclusion of an intercept term in the relationship ( $y=a+bx$ ), the ratio  $y/x$  is still dependent on size and will not provide satisfactory control.

d. If the variable under examination depends not only on size, but also on some additional variables ( $y=a+bx+cz$ ), deflation by size will also affect the additional variable resulting in inadequate control for size.

Given the above problems, the use of financial ratios should be accompanied by a theoretical justification and an empirical analysis of the degree to which the data meet the ratio assumptions. The primary objective of using the ratio must be established. If the primary interest centers on the simple correlation between the numerator series, it is not appropriate to deflate these values. Deflation is important when the primary interest is in the partial correlation of the numerator series. In such situations, the denominator value must be controlled. It is important to note that the raw and deflated quantities reflect different variables. A hypothesis formulated in terms of one variable cannot be directly tested using data based on another variable.

When deflation is deemed appropriate, considerations for the choice of the size variable should include:

- a. The availability of appropriate market references.
- b. The strength of correlation and homogeneity of the examined variable to the size measure.

c. The extent of measurement errors in the size variable.

The use of negative numbers in computing the ratios results in a loss of continuity, which frequently causes interpretation problems. When the numerator of a ratio is a flow variable that can take negative values, and the denominator is a stock variable, it is suggested that the ratio be replaced by the ratio of consecutive observations on the stock variable.

Finally, Lev and Sunder indicate that selection of appropriate industry-wide standards depends on:

a. The underlying theoretical reasons as to why firms within the same industry are expected to have similar or dissimilar ratios.

b. The distributional properties of the financial variables and ratios. The value-weighted mean appears to be most representative of industry-wide measures of location for normally distributed values, while the median is most representative for lognormally distributed variables.<sup>24</sup>

Structural models. Kinney and Salamon [1978] investigated the effect of errors in the independent and dependent variables of regression models applied to financial information. Simulated data was used, consisting of 200 data sets with 48 observations per set.

The authors developed a flowchart describing the procedures which should be followed when conducting analytical review using least squares estimation models. These procedures include calculation of the estimated total accounting error and the upper precision limit on total overstatement error. The decision rule

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<sup>24</sup>Ibid., pp. 187-210.

used during the analysis was a comparison of the upper precision amount with the materiality threshold.

Four conditions of accounting error were examined and subsequently seeded into the data sets: (a) no accounting error, (b) one error equal to materiality, (c) three equal errors with a cumulative total equal to materiality, and (d) twelve equal errors with a cumulative total equal to materiality.

The results indicate that random measurement errors in the independent variable leads to increased type I and type II errors. Based on this analysis, the authors suggest that past adjusting journal entries proposed by auditors during examinations in prior periods be corrected prior to using past audited data for regression analysis.<sup>25</sup>

Collins [1980] investigated the impact of model specification errors on the effectiveness of stepwise regression with respect to its ability to indicate the existence of material accounting error in relation to an appropriately specified and estimated model. An econometric model using data simulated from interest revenue accounts of a medium size commercial bank was used as the data base. Simulations were based on 100 replications of four years of monthly activity.

Known accounting errors were seeded in the monthly data using five different allocation methods: (a) distribution to a single month, (b) distribution across four months, (c) distribution irregularly across four months, (d) distribution equally over twelve months, and (e) distribution equally over the three months which had the smallest true residuals.

Collins estimated two models to form predictions of the audit

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<sup>25</sup>Kinney and Salamon, "Effect of Measurement Errors," pp. 49-64.

period account balances. Both models relied on a thirty six month base period. Defining materiality as the range of five to ten percent of net income, a hypothesis-test-based auditor decision rule was employed to establish investigation cutoff values for accounts.

Stepwise regression, on average, includes nongenerating variables and excludes generating variables. This characteristic influences the model building process. Relying on stepwise regressive techniques, the correct model was selected only two percent of the time. In addition, the stepwise estimates of residual variances are more biased, resulting in an understatement of the standard error of prediction and reducing the overall effectiveness of the technique. Collins concludes that if the auditor is aware of the relationships in the data sets, then stepwise regression is not necessarily the most appropriate method for estimating the model.<sup>26</sup>

Meter [1980] investigated some of the major statistical issues in implementing the regression approach for analytical review. Two sets of sample data were used: (a) time series data, using accounts receivable balances at the divisional level of a firm, and (b) cross sectional data, using sales outlets of a major retail chain.

A large pool of potential predictor variables was generated, and stepwise regressive techniques were used to estimate the model. Both additive and multiplicative independent variables were included. Relevant independent variables were identified by an audit staff.

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<sup>26</sup>Dennis J. Collins, "Analytical Review: The Problem of Model Validity," paper presented at the Fourth Duke University Symposium, 1980, pp. 1-29.

In the first sample of time series data, Neter found (a) substantial multicollinearity among the predictor variables, (b) favorable comparisons between the predictive ability of models developed from variables selected by auditor judgement and models developed using stepwise techniques, and (c) consistent levels of predictive ability using substantially different sets of economic variables, which again implies multicollinearity.

For the cross-sectional data, Neter found that: (a) the regression model could identify the exception outlets, but not the reason for the exception status, (b) traditional techniques which flag exceptions when the change in net sales is greater than three standard deviations of all changes, tend to identify smaller outlets with overstatements of sales, and (c) auditors were able to identify potential independent variables.<sup>27</sup>

Kinney [1979a] developed a methodology where regression based analytical review is used as a potential means of reducing tests-of-details sample size. Simulated data of 200 audit years was generated by randomly adding material accounting error to the residuals of audit months.

For a given series of simulated data, the number of signalled errors was collected. These were classified as type I if excess was identified for a month with no seeded accounting error, and type II if no excess was identified for a month with a seeded accounting error. The signal errors were used to revise the sample size for the Dollar Unit Sampling technique.

In situations where no accounting error was found, the use of regression and partitioning within the audit year allowed a 59

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<sup>27</sup>John Neter, "Two Cases on Use of Regression for Analytic Review," paper presented at Symposium on Auditing Research IV, University of Illinois, 1980, pp. 1-31.

percent reduction in the required sample size. Regression without partitioning allowed a 33 percent reduction. With the introduction of material accounting error, partitioning distinguishes between alternative concentrations of error with savings in sample size. If single monthly errors occur, or three months with one-third of the total material error in each month, the integrated procedure failed to extend the sample size 14 percent of the time. Additionally, 7 percent of the single months with material error, and 30 percent of the months with one-third of the material error were not signaled for investigation.

Kinney concludes that the integration of analytical review and detailed tests of transaction balances can lead to savings during an audit. But to justify a precise account balance probability statement based on regression results, the auditor must be able to show that the base period model seems to be valid for the audit period. The regression results must be sufficiently precise to allow adequate confidence that the maximum accounting error is less than a material amount. Kinney also suggests that the residuals of the regression should be evaluated. If outliers exist in the audit period, then an environmental variable was omitted, an accounting error is present, and/or some rare outcome has occurred.<sup>28</sup>

Assessment of research. The empirical research on methodological issues addressed four areas; financial ratios, regression models, the nature of some accounting data, and integration of the results of analytical review procedures with other substantive tests.

Errors in the financial data may distort the measured

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<sup>28</sup>Kinney, "Integrating Audit Tests," pp. 456-75.

relationship between financial ratios due to inadequate size control. Auditors must ensure that theoretical justification, rather than convenience, is the basis for using the selected financial ratios.

In the analysis of regression techniques, it was found that measurement error in the independent variables will produce increased type I and type II errors. Additionally, the use of stepwise selection procedures during model development tends to include extraneous variables which are not in the actual structural relationships, and tends to understate the standard error of prediction.

An auditor should consider the characteristics of the accounting information before applying a statistical model. The presence of multicollinearity in time series accounting information from accounts receivable data implies that multiple regression techniques cannot be directly applied to this data. It was also found that when regression models are used with cross-sectional data, they identify exceptions better than traditional analytical review techniques, but they still cannot provide the reason for the exceptional status.

Finally, it was found that the results of regression based analytical review techniques can be integrated with tests of details based on dollar unit sampling. This integration can result in a decreased sample size for the detailed tests of transactions and balances.

#### The Nature of Accounting Errors

##### Specific research activities

Ramage, Krieger, and Spero [1979] sought to identify the basic characteristics of audit populations in a parametric

form. Two samples were used in this study. Both samples were drawn from 111 populations of audited accounts supplied by Peat, Marwick, Mitchell & Co. (PMM) The first sample consisted of 97 populations, with 14 eliminated due to incomplete data. Of the remaining populations, 67 percent were accounts receivable populations and 30 percent were inventory. The second sample consisted of 50 populations for which ten or more errors were detected. Accounts receivable comprised 58 percent of the sample, while 40 percent was composed of inventory.

The average error rate was calculated for the 97 populations, using a weighted average of errors per stratum. The fraction of overstatement errors, measured as the weighted average of the percentage of overstatement errors per stratum, was calculated for the 50 populations with 10 or more errors. Contamination errors were also computed for the 50 populations with 10 or more errors. Contamination errors are those with large magnitudes relative to the audit value. The authors used the relative magnitude of the audit value relative to the book value as the measurement for contamination error [  $(\text{audit value} - \text{book value}) / \text{book value}$  ]. This measurement is restricted to overstatement errors.

The results indicate that most of the high error rate populations represent inventory accounts. Low error rates were found in 72 percent of accounts receivable populations, while 24 percent of inventory populations had low error rates. Error rates were found to vary by the Standardized Industrial Classification (SIC) code. These variations were statistically significant.

In most populations, the error rates were essentially constant across strata. None of the 97 populations gave strong evidence of decreasing error rates. Nine populations (of which eight were accounts receivable) exhibited some evidence of an increasing error rate across strata.

Accounts receivable populations tended to have overstatement errors. The differences in the distributions of accounts receivable populations and inventory populations were statistically significant. However, inventory populations were found to have significantly lower contamination rates.<sup>29</sup> (Note, since the contamination measure is restricted to overstatement errors, and accounts receivable populations were found to have mostly overstatement errors, this result would follow.)

Johnson, Leitch, and Neter [1981] sought to investigate error distribution characteristics and the relationship between errors and book values in accounting populations. They used the same 111 audited populations supplied by PMM, selecting 55 audits of accounts receivables and 26 audits of inventory. The populations included were audits where statistical sampling was applied and errors found.

The error rates were analyzed to obtain information about the magnitude of error rates, the susceptibility of individual items within an account to error, and the comparative prevalence of overstatement and understatement errors. Four strata of equal size were used for this analysis. To study the error rates and analyze the error distributions of individual line items, the ten accounts receivable and inventory audits with the largest number of errors were selected. For each audit, the line items were grouped according to book value to get three equal size groups.

These results also indicate that there is a great variability in error rates. Error rates for inventory tend to be substantially higher than those for accounts receivable. Error rates for the

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<sup>29</sup>John G. Ramage, Abbe M. Krieger, and Leslie L. Spero, "An Empirical Study of Error Characteristics in Audit Populations," Journal of Accounting Research 17 (Supplement 1979):72-102.

largest accounts tend to exceed those for the other groups. Error rates tend to increase as the size of the line item increases.

The error amount distribution for both accounts receivable and inventory are far from normal, with high positive skewness. Errors in accounts receivable audits predominantly were overstatement errors, while inventory audits were more balanced with understatement and overstatement errors. The mean error amounts for accounts receivable audits tended to be larger and less variable than the inventory audits. The standard error amount distributions for accounts receivable and inventory audits were similar but with consistent differences. This suggests that there may be different error generation and transaction processes, and different audit processes may be appropriate considering the error distribution of the two types of accounts.<sup>30</sup>

Hylas and Ashton [1980] performed an empirical study which focused on the account classification and amount of adjustments resulting from errors, the initial events that led to detection of the errors, and the apparent causes of the errors. The data consisted of 281 errors requiring financial statement adjustments on 152 audits of financial statements for firms of various size and industry.

No errors were found in 37.5 percent of the audits. Of the 281 errors which were detected, 56 percent were found in audit areas of revenue cycle and accounts receivable, purchases cycle and accounts payable, inventory and production costs, prepaid expenses, and property, plant and equipment. Of the reported errors, 51 percent would have resulted in income overstatement, while 36

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<sup>30</sup>Johnny R. Johnson, Robert A. Leitch, and John Neter, "Characteristics of Errors in Accounts Receivable and Inventory Audits," The Accounting Review 56 (January 1981):270-93.

percent would have resulted in income understatement. Thirteen percent of the reported errors had no effect on income.

More errors were detected by analytical review than by any other category of initial events. The definition of analytical review included comparisons of current balances with those of prior years, predictions of correct balances based on exogenous data, and analysis of account balance interrelationships.

Client personnel problems were identified as the cause in 21.5 percent of the 281 errors detected. Insufficient accounting knowledge was identified as the cause of 15 percent of the errors. The use of judgement in estimating certain items was associated with 15.3 percent of the errors, while cutoff or accrual procedures were associated with 38.1% of the errors. Ten of the 281 detected errors were considered to be irregularities (intentionally caused errors).

Extremely large errors (more than two percent of total assets) were found in 11 of the 17 audit areas. Those areas with the most errors were the revenue cycle and accounts receivable, and property, plant and equipment. No large errors were found in notes receivable, prepaid expenses, purchases cycle and accounts payable, other liabilities and deferred credits, and other income and expenses. Analytical review was instrumental in detecting 11 of the 26 large errors.<sup>31</sup>

The purpose of the Smith [1980] study was to identify the major transaction types and associated potential errors for the sales and collection cycle. He analyzed accounts for a product oriented company with a manual system of accounting.

An error analysis framework was applied to the account data.

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<sup>31</sup>Hylas and Ashton, pp. 1-26.

Seven types of transactions were identified as applying to the sales and collection cycle. The specific types of errors that could occur within these transactions were identified, based on discussions with CPAs, examination of working papers, and review of leading auditing textbooks. The impact that each identified error would have on the financial statements was analyzed analytically. Preventive and detective controls were identified that could be employed to reduce the probability of the error occurring and not being detected. For each of the defined controls, at least one compliance test was defined. Under the assumption that the controls were either missing or inadequate, interim and final substantive tests were defined and categorized. Each category was analyzed separately as to the evidential power (effectiveness) and cost (efficiency). Emphasis was placed on understanding what evidence is provided by performing the audit procedure.

Smith concludes that application of the error analysis framework can identify the errors that could occur in an accounting system. Based on such an analysis, the necessary audit procedures can be identified. The specific audit procedures used should consider the cost of the procedure and the evidential power.<sup>32</sup>

#### Assessment of research

The following limitations apply to the first three studies of error characteristics which used actual client data:<sup>33</sup>

- a. Since the authors were specifically interested in

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<sup>32</sup>Jay M. Smith, Jr., "An Analysis of the Effectiveness and Efficiency of Substantive Auditing Procedures," (Brigham Young University, 1980) pp. 1-156.

<sup>33</sup>Ramage, et al.; Johnson, et al.; and Hylas and Ashton.

error characteristics, the error rates discovered may be higher for the set of populations than usual.

b. There may be selection biases due to the specific time periods or characteristics peculiar to PMM clients.

c. The analysis is limited to those errors that were identified during an audit. This implies that only material errors were included in the analysis. Neither study addressed the distribution of all potential errors within the accounts. As a specific example, consider the case of a material error existing in one month of the current audit period, or the same total amount of error spread evenly over the twelve months in the current audit period. In the later case, the monthly component of the total error may not be material. And, some statistical sampling techniques may not detect such errors. Thus, the above studies do not address all the potential error distributions.

d. One purpose for analyzing error distributions is to access the relative reliability of alternative audit techniques and procedures. The above studies analyze the distribution of errors found by audit techniques and procedures. The use of these distributions to evaluate the relative reliability would be circular. Hence, the nature of errors within accounts should be analyzed independent of the audit techniques and procedures. The error analysis approach employed by Smith is one method of achieving this independent study of errors. However, Smith's analysis does not address the distributional characteristics of the errors. He merely identifies the potential errors which could exist, and then identifies compliance and substantive tests which could be used to detect such errors.<sup>34</sup>

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<sup>34</sup>Smith, pp. 1-156.

### Summary

The results of research which evaluates the predictive accuracy of analytical review methods imply that it is not appropriate to use a single analytical review method for all potential applications. Any one analytical review method may provide the best prediction accuracy, depending on the specific circumstances in which it is applied.

The majority of research on analytical review procedures focuses on the comparisons of alternative techniques for specific account types within specific industries. Heuristic, ratio and bivariate analysis techniques have been compared across various accounts of small manufacturing firms. Regression, Box-Jenkins and time trend techniques have been compared across revenue, operating expense, and administrative expense accounts within the railroad industry. Regression has been compared to unspecified "traditional" techniques across revenue and operating expense accounts within a utility. Index models were compared with a time trend technique across sales, operating revenue, and net income accounts within fourteen industries. There does not appear to be any published research which compares the effectiveness and efficiency of subjective, traditional and structural techniques across the same set of financial data.

No published research could be found which examined the analytical techniques and procedures typically used by auditors, and the financial accounts that they are typically applied to. This type of analysis is necessary to incorporate the research results with the practical applications of analytical review. It is possible that for certain financial relationships, traditional techniques are as or more effective than the corresponding

structural model. And less effective methods may still provide the desired degree of audit assurance. Hence, research is needed that assesses the effectiveness of alternative analytical procedures typically used during an audit.

The research concerning methodological issues tends to focus on implementation of the regression technique. Such studies do not adequately address all factors which should influence selection of the analytical review procedure.

The studies concerning the nature of accounting errors show the distribution of errors discovered by audit procedures and techniques, not necessarily the actual distribution of errors within the accounts. An error analysis approach was employed by Smith to identify the sources of errors within the sales and collection cycle. The results of this analysis were used to identify potential compliance and substantive tests, and did not address the distributional characteristics of the errors.

In general, the results of existing studies concerning analytical review techniques and procedures have limited application to practical situations. This limited generalizability is due to:

a. The types of traditional techniques currently used in practice have not been identified. From a practitioners' viewpoint, research in this area should inform the auditor of the effectiveness of procedures typically used rather than the effectiveness of techniques suggested for use.

b. Analysis of alternative analytical techniques should be based on accounts and account relationships typically analyzed during an audit. It has been shown that no single analytical technique works best in all audit situations. Investigations showing the relative effectiveness of alternative

analytical techniques applied to typically analyzed accounts and account relationships would increase the generalizability of this research.

c. The decision rules used with traditional analytical techniques were arbitrarily chosen. Although some studies did use several critical values to show the sensitivity of the decision rules, it should be possible to develop a set of decision rules which are commonly used in practice.

d. The sensitivity of the decision rules to the size and distribution of the aggregate error in the financial accounts should also be evaluated. Research indicates that the performance of regression decision rules is affected by the size and distribution of the aggregate error in the accounts. This association may also exist for decision rules applied to traditional techniques. Thus, analysis of the performance of alternative procedures should incorporate knowledge of the expected size and distribution of the aggregate error in the financial accounts.

In conclusion, the existing literature emphasizes the implementation and comparison of analytical review techniques within a specific context. The contention in this study is that selection guidelines must be developed first to ensure that appropriate analytical review alternatives are compared. Within the specific contexts where the analytical review techniques are appropriate, comparisons of their relative effectiveness and efficiency are valid. The results of these comparisons may then be used to develop guidelines to aid auditors in the selection of analytical review procedures, which explicitly consider environmental context and the relative effectiveness and efficiency of the alternative techniques within that context.

## CHAPTER III

### RESEARCH METHOD

#### Introduction

The objective of this study is to develop guidelines to aid auditors in the selection of analytical review procedures. These guidelines result from a comparative analysis of analytical review procedures. This chapter will describe the research method used to conduct the comparative analysis.

An overview of the comparative analysis process is presented in Figure 1. The components of the overall process are categorized as data sources, simulation processes, and data bases. The simulation processes compose the simulation model developed for this study. The data sources provide external information which is used to develop the various levels of control for the operation of the model. Hence, the data sources form the control parameters for the model. Three data bases are required for the simulation model: (a) financial data sets, which are based on a model of an accounting information system and external financial data, (b) simulation data sets which form the basis for the comparative analysis, and (c) a collection of the resulting type I and type II error rates categorized according to specific control parameters.

The comparative analysis process is discussed in this chapter. First, the comparison criteria for the study are established. The discussion then turns to development of a model for the accounting function in a medium-sized manufacturing firm.

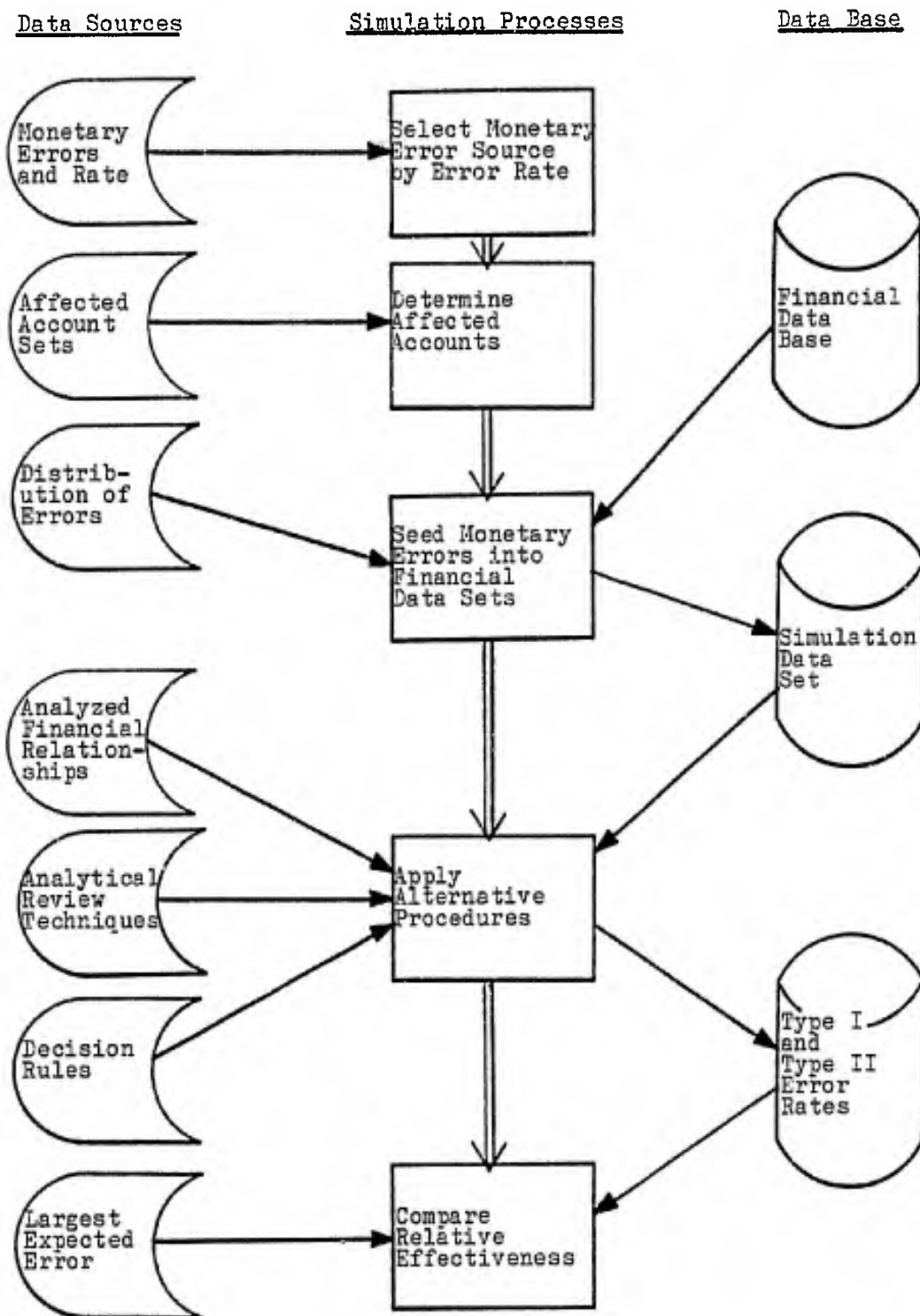


Fig. 1. Comparative analysis process.

This model introduces some key assumptions concerning the nature of the financial data analyzed in this study. The accounting model forms the basis for the financial data base employed during the simulation process. Once the structure of the financial data base is established, the characteristics of the financial data entered into the financial data base are presented.

Next, the data source components are addressed. To facilitate discussion, the data sources will be categorized as relating to analytical review procedures, the nature of accounting errors or affected account sets. Finally, the function of each process in the simulation model is analyzed, integrating the data sources and the data bases. The research design used to gather the information contained in the data sources is presented in Chapter 4.

#### Comparison Criteria

Evaluating the relative efficiency and effectiveness among alternative analytical procedures requires use of comparison criteria that are consistent across the methods. Most of the empirical studies comparing analytical techniques used the predictive ability of the alternative analytical review methods as the criterion for comparison. Both Kinney [1976] and Lev [1980] indicate that the most desirable comparison basis is complete type I and type II error analysis. However, this is considered improbable in many applications since it requires complete analysis of all observations, and the costs and consequences associated with type I and type II errors are difficult to estimate.

Kinney [1976] asserts that the next best alternative criterion is prediction achievement. This criterion selects

the method which has the best predicted audited values under similar conditions in the past data.<sup>1</sup> Three studies used prediction achievement as the criterion:

a. Kinney [1978] used the smallest mean error as a measure of the bias of predictions, and the smallest mean absolute error as a measure of dispersion.

b. Albrecht and McKeown [1978] selected the analytical review method with the best prediction accuracy of the base period, using the residual standard error to compare the fit of the model with the historical time series data.

c. Lev [1980] cites two comparison criteria: determine the significance in relation to some specified materiality factor, or determine the significance in a probabilistic way by using the standard error of prediction. (The latter method is only appropriate when the prediction of the independent variables can be made without error.) In his study, Lev used the mean prediction error as the basis for comparison.<sup>2</sup>

In deciding on criteria for comparison, one must consider the purpose for which the analytical review procedure is applied. For attention direction applications, a high degree of reliability is required since the results influence the extent of substantive testing. As a substantive test, analytical review procedures should have a level of reliability which is comparable to the alternative detailed tests. Both applications infer that the comparison criteria should be based on how well the procedure

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<sup>1</sup>William R. Kinney, Jr., "Discussants Response to 'Toward an Extended Use of Statistical Analytical Reviews in the Audit,'" Symposium on Auditing Research II (Urbana, IL: University of Illinois, 1976), p. 75; and Lev, p. 539.

<sup>2</sup>Kinney, "ARIMA and Regression," p. 57; Albrecht and McKeown, p. 64; and Lev, pp. 538-42.

achieves the desired reliability level.

Type II error rates may provide the best measure of a procedure's ability to achieve the specified reliability level. Type I error rates may be the best measure of efficiency. Thus, the criteria used in this study are the type I and type II error rates. Kinney [1979b and 1981] and Kinney and Salamon [1981] also used the percentage of type I and type II errors to compare alternative analytical review methods.<sup>3</sup>

A comparison of alternative analytical review procedures based on the type I and type II error rates requires an error-free financial data base. The process of developing an error-free financial data base makes certain assumptions concerning financial accounting models. The next section will develop a financial accounting model and explicitly state the necessary assumptions.

#### Development of the Accounting Model

Within this study, a clearly specified structure must be provided to allow for the application of statistical and simulation tools. Construction of a semantical model allows introduction of the simplifying assumptions necessary to perform mathematical analysis, yet retains a structural similiarity to the original situation which the model is intended to describe.<sup>4</sup> For the purpose of this study, it will be necessary to develop a semantical model of the accounting function for a medium-sized manufacturing firm.

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<sup>3</sup>Kinney, "Predictive Power of Limited Information," p. 131; Kinney, "Paired Balance Methods," p. 11; and Kinney and Salamon, "Alternative Investigation Rules," p. 9.

<sup>4</sup>Abraham Kaplan, The Conduct of Inquiry (New York: Chandler and Harper & Row, n.d.), pp. 273-74.

A systems model of the  
accounting function

The accounting function has an important role in the successful operation of an entity. It centers on providing relevant financially oriented, decision making information to parties both within and outside of the entity. Since the accounting function converts data into information, it will be modelled as a system.

A systems model typically consists of input, processing, and output. In addition, control must be performed.

Input represents those items which are brought into the system for processing. The basic inputs to the accounting function are transactions resulting from the occurrence of an economic event. In order for a transaction to be processed by the accounting function, it must be recognized as having a potential effect on the financial information and rendered in a form that can be processed. Within this accounting model, the transactions are the source documents which capture the results of the operating actions that are an integral part of the entity's activities (sales invoice, time cards, credit memos, etc.).

Processing represents a transformation of the items that have entered the system as input. Within the accounting function, processing represents the execution of a series of tasks by which the transactions are recognized, authorized, calculated, classified, recorded, summarized, and reported. It is assumed that the state of financial information maintained by the entity can only be altered during the processing of transactions.

Output represents a result of processing. Output from the accounting function will take the form of financial statements or other reports and analyses provided to internal and external

parties.

Control in a system is the process of effectively directing the activity so that it stays within desired limits. For the accounting function, the term internal control is normally used. The AICPA defines internal control as encompassing both administrative control and accounting control. Administrative control pertains to operating efficiency which enables management to achieve its prescribed policies and goals. Accounting controls are established with the objective of preventing some inefficiency from occurring. Auditors are primarily concerned with accounting controls. According to the AICPA:

Accounting control comprises the plan of organization and the procedures and records that are concerned with the safeguarding of assets and the reliability of financial records and consequently are designed to provide reasonable assurance that:

- a. Transactions are executed in accordance with management's general or specific authorization.
- b. Transactions are recorded as necessary (1) to permit preparation of financial statements in conformity with generally accepted accounting principles or any other criteria applicable to such statements and (2) to maintain accountability for assets.
- c. Access to assets is permitted only in accordance with management's authorization.
- d. The recorded accountability for assets is compared with the existing assets at reasonable intervals and appropriate action is taken with respect to any differences.<sup>5</sup>

#### Assumptions of the model

For the accounting model used in this study, it is assumed that an internal control system exists within the model of the accounting function. Figure 2 depicts the relationship between the major activities of the accounting model, and the types of journals and ledgers maintained by the accounting function.

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<sup>5</sup>AICPA, Codification, sec. 311.07.

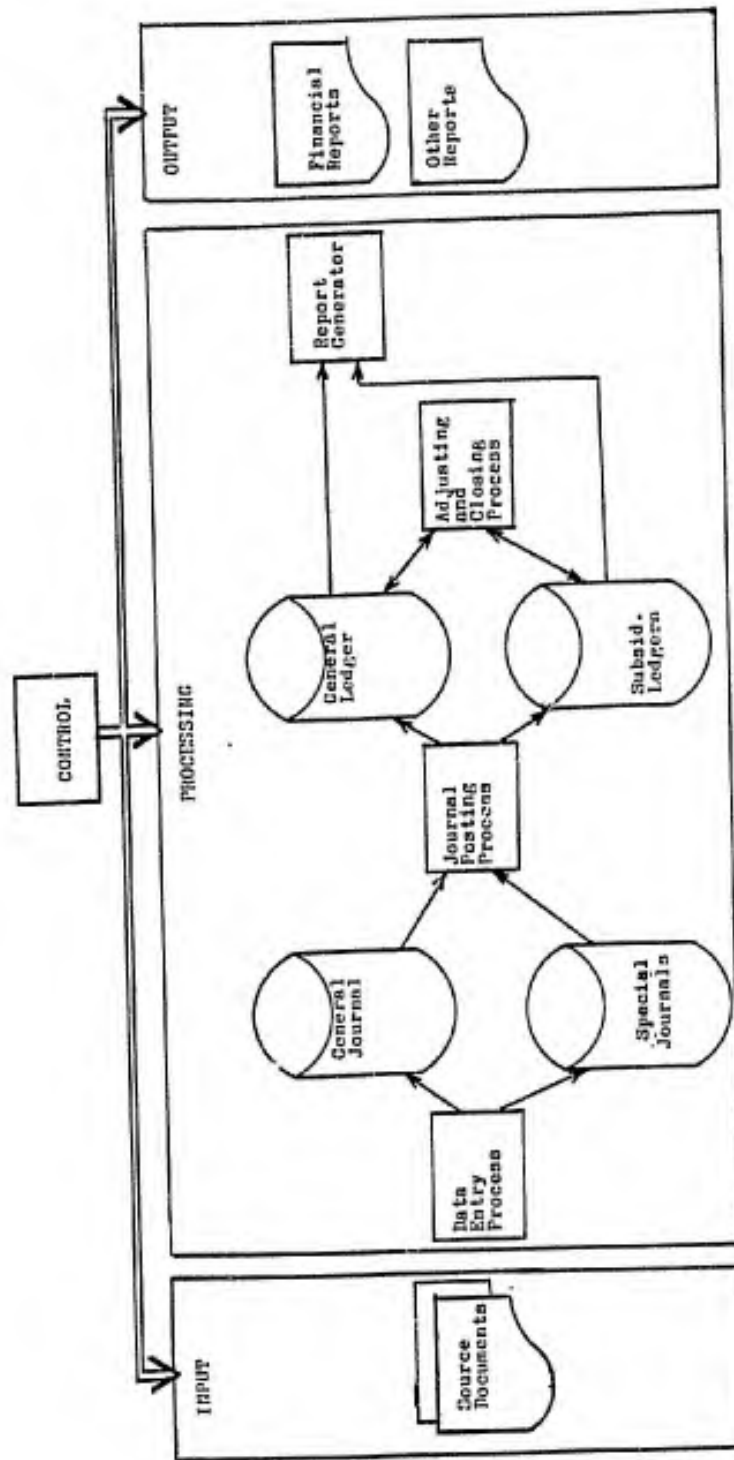


Fig. 2. Model of accounting information system.

Another basic premise of the accounting model is that errors must be introduced into the accounting information. If all source documents are entered correctly into the system, and the information from these documents is processed correctly, then only error free data will enter the system.

Note that there is a distinction between error free and accuracy and reliability. As acknowledged by the Commission on Auditors' Responsibilities: "Accounting results - the financial statements - cannot be more accurate or reliable than the underlying accounting measurement methods permit."<sup>6</sup> There is a difference between a variation in the measurement and a mistake in the measurement. For example, different measurements may be obtained from applying the gross profit method or relative sales method for evaluating inventory. Since both methods may be acceptable in a given situation, variation may result in the measurement due to the method applied. A mistake in the measurement would occur if the method is incorrectly applied. Errors and irregularities result from unintentional and intentional mistakes.

In actual practice it may be difficult to distinguish between a mistake and an allowable variation. Mautz and Sharaf define truth in auditing as "...conformity with reality as the auditor can determine reality at the time of his examination and with the evidence available."<sup>7</sup> This study assumes that the auditor can determine reality with respect to the financial information entered into the accounting system via source documents.

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<sup>6</sup>The Commission on Auditors' Responsibilities, Report, Conclusions, and Recommendations (1978), p. 7.

<sup>7</sup>R. K. Mautz and Hussein A. Sharaf, The Philosophy of Auditing (Sarasota, Fl: American Accounting Association, 1961), p. 85.

Given this assumption, errors and irregularities are introduced only during the processing of transactions. The sources of errors and irregularities are directly related to the types of transactions processed. This also means that the effect of a monetary error resulting from such sources is limited to those financial accounts which are affected by the transaction.

The transaction based accounting model described above facilitates error analysis. For each transaction which is processed by the system, the potential sources of errors and irregularities can be identified. From these potential sources, the ensuing monetary error and its impact on the financial accounts can be ascertained. The research question is oriented toward determining the effectiveness of analytical review procedures in detecting the resulting monetary errors. Thus, the next step is to build the financial accounting model from error free financial information.

#### Development of Financial Data Base

Actual data from two medium-sized manufacturing firms were obtained and used as the basis for the financial data base. Selection criteria for the firms included:

- a. Size of \$10-200 million in annual sales, which ensures some degree of consistency in the accounting information systems for the firms. This and other studies assume that a minimum size constraint provides an expectation of reasonably adequate internal accounting control while a maximum size constraint excludes large firms which have highly individualized accounting systems and audit problems.<sup>8</sup>

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<sup>8</sup>Kinney, "Predictive Power of Limited Information," p. 154.

b. Homogeneity of products within the firm, which ensures consistency in the internal operations of the firm.

c. Organization as a single entity to eliminate accounting problems associated with consolidated statements and intercompany transfers.

d. Recommendation by practicing auditors that the firm's operations are representative of medium-sized manufacturing operations.

The audited financial data obtained from these firms were used as a basis for evaluating the ability of alternative procedure sets to detect monetary errors. However, it is assumed that audited financial data do not contain material accounting errors. It is acknowledged that this data may not be error free. It is likely that small fluctuations in the financial data may be caused by non-material errors.

The presence of a material monetary error may be detected by an analytical procedure when the procedure identifies significant fluctuations in the financial data. These fluctuations are measured as the difference between the expected value generated by the analytical procedure and the book value. This difference may be caused by material accounting errors and irregularities or by changes in the accounting environment which influence the processes and financial activities of the firm.

To increase the analytical procedure's ability to distinguish normal fluctuations from monetary errors, it is important that the financial data be adjusted for changes in the accounting environment. Such changes could be caused by: (a) changes in accounting principles, (b) changes in the business conditions, such as new product lines, labor disputes, etc., and (c) the occurrence of unusual events.

In the financial data for one firm, one month in the base period was altered to correct for an unusual event. This unusual event only affected the operational accounts. The administrative functions did not require compensation. To compensate for the unusual event in the operating accounts, a time series regression was applied to the year, excluding the affected month. The balances used for the affected month were then predicted from the model. This resulted in smoothing the data for one month in the base period.

With respect to the nature of the data and time intervals used in audit practice, Stringer indicates the following:

For time series applications, the observations ordinarily consist of the recorded amounts of monthly transactions or balances, although other time intervals are used in some cases. In such applications, the observations are divided into a base period and a projection period, the former consisting of prior audited periods and the later being the current audit period.<sup>9</sup>

Stringer further states that a base period of thirty-six months is ordinarily used with monthly data. Therefore, a forty-eight month period was used for each financial data set.

The results of applying alternative analytical procedures are expected to vary with the economic conditions reflected in the financial data sets. This implies that variations may occur both across firms for the same time period, and within firms for different time periods. To assess the extent of these variations, a minimum of four financial data sets was required. This minimum set consists of two firms, with two overlapping forty-eight month periods per firm. After the financial data was adjusted to correct for environmental changes, it was entered into the financial data

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<sup>9</sup>Stringer, p. 6.

base model.

Thus, the financial data base for the simulation model is composed of four distinct financial data sets. Before discussing the processes accomplished within the simulation model, it is necessary to define the data source components. The first data source category relates to analytical review procedures.

### Analytical Review Procedures

Empirical studies indicate that analytical review procedures are perceived as being an important part of the audit process and are being employed by practicing auditors to detect financial statement errors.<sup>10</sup> Although numerous studies have investigated the performance of traditional and structural analytical methods, few studies have inquired into the type of analytical procedures that are actually used by practicing auditors. Assessment of the typically used analytical procedures requires an examination of the analytical techniques employed, the decision rule used to signal an investigation, and the financial relationships that are analyzed.

### Analytical techniques

Three analytical techniques are commonly applied to financial relationships to form an expectation of the audit value. These are: (a) reasonableness tests, which are judgemental in nature, (b) traditional analysis, which looks at the change in the financial relationships over time, and (c) regression of one account with respect to one or more related accounts.

The difference between reasonableness tests and traditional analysis is minimal. A reasonableness test does not require strict

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<sup>10</sup>McAllister, et al., p. 6; and Hylas and Ashton, p. 9.

use of some analytical technique to generate an expected value, nor does it require the application of a quantified decision rule. The objective of the test is to determine if the changes in account balances are as expected, incorporating the insight and general knowledge of the auditor concerning economic, industry, and firm conditions. The reasonableness test is multivariate in nature, and allows the auditor to incorporate intangible, non-quantifiable information into the process of generating expectations.

Traditional analysis may involve evaluation of financial ratios or a time series analysis of the financial balances. A ratio expresses a relationship between two or more accounts. Specification of such relationships should be accompanied by theoretical justifications to ensure that the relationship between the accounts is meaningful. A ratio evaluates the linear mathematical relationship between the accounts. Mathematically, this relationship is expressed as:  $y=bx$ . The slope of this relationship must pass through the origin.

A time series analysis is a set of observations taken at equal intervals. A time series behavior should reflect the following components: (a) general long-term trend, (b) seasonal movements, and (c) random variation.<sup>11</sup>

Once the components of the time series are identified, expectations may be projected using the historical data. Such projections are based on the long-term trend with inclusion of appropriate seasonal coefficients.

Regression analysis can be used for both linear and non-linear relationships between one or more dependent variables and

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<sup>11</sup>Ronald J. Wonnacott and Thomas H. Wonnacott, Econometrics (New York: John Wiley & Sons, 1970), pp. 199-209.

one or more independent variables. The methodological issues which must be considered when performing regression analysis were discussed in Chapters 1 and 2. Restricting the regression to a simple linear model will negate the concerns for many of these issues. In fact, the simple linear model can be viewed as a ratio analysis which includes an intercept coefficient and an error term ( $y=a+bx+e$ ). Viewed in this manner, the major differences between regression and ratio analysis are in the amount of historical data used to generate the expectation (regression requires a minimum of 36 periods while ratio analysis requires only the previous audit period) and the form of the decision rule applied to the financial data. The use of more data points and an intercept coefficient in the regression model should produce more consistent expectations than the ratio analysis. The simple linear model can also be used to generate time series projections based on the long-term trend in the historical data.

The form of the monthly data entered into the regression model differs for income statement and balance sheet accounts. The regression model is used to predict the monthly balances for the dependent variable account from the independent variable account (for example, predicting gross profit from net sales). The objective of applying the regression technique is to model the monthly flow within the financial accounts. For income statement accounts, the monthly changes in the cumulative balances represent these monthly flows. Thus, the input data for income statement accounts consists of the monthly changes in the cumulative balances. For balance sheet accounts, the cumulative balance in the account provides the information concerning monthly flows. Thus, the cumulative balances are entered for balance sheet accounts, not the monthly changes to the cumulative balances.

Since some of the input data for the regression analysis represents a time series, there exists the potential for bias due to serial correlation in the residuals. Serial correlation between the error terms is often found in time-related data such as financial account balances. In most situations, the effects of serial correlation can be negated through transformations on the data.

Kinney [1978] suggests the use of the Cochrane-Orcutt transformation when serial correlations are present.<sup>12</sup> In a Monte Carlo study of auto-correlated errors, Rao and Griliches found that there was a significant gain in efficiency from using two-stage estimation procedures, such as a two-stage Cochrane-Orcutt transformation, for moderate and high levels of serial correlation. There was very little loss from using such methods when the level of serial correlation was small. The performance of the two-stage Cochrane-Orcutt transformation was comparable to other transformation methods.<sup>13</sup>

Empirical information concerning the type of analytical techniques employed during an audit is not available. Thus, it is necessary to determine the extent to which each of the three analytical techniques is applied in practice. To derive this information, practicing auditors were asked to indicate which analytical techniques they normally apply to various financial relationships during an audit of a medium-

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<sup>12</sup>Kinney, "ARIMA and Regression," p. 53.

<sup>13</sup>Potluri Rao and Zvi Griliches, "Small-Sample Properties of Several Two-Stage Regression Methods in the Context of Auto-Correlated Errors," Journal of American Statistical Association, March 1969, pp. 253-269.

sized manufacturing firm.<sup>14</sup>

### Decision rules

In conjunction with the type of analytical technique used, the decision rule applied must also be identified. Decision rules are used to determine when to investigate a fluctuation in the financial balances. An analytical technique is applied to financial data to generate an expected value. A decision rule incorporates the specified reliability level by generating a precision interval around the expected value. This precision interval is compared to some specified criterion to signal significant fluctuations in the financial data.

Decision rules are not unique to the analytical technique and the form of the analytical technique does not dictate the form of the decision rule. Within this study, decision rules are categorized as follows:

a. Statistically based decision rules, where the reliability associated with the decision rule is explicitly stated.<sup>15</sup> Statistical decision rules are often associated with structural models, and may also be used with traditional analysis methods.<sup>16</sup> For example, a regression decision rule would be to investigate

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<sup>14</sup>See section II of Appendix C, Interview Guide. The results are presented in Chapter 4.

<sup>15</sup>All forms of decision rules incorporate both precision and reliability. Precision is a measure of closeness between a sample estimate and an unknown population parameter (expressed in dollars). When precision is added to and subtracted from the estimated audit value, it yields a precision interval. Reliability is a measure of the probability that the unknown population parameter (the true audit value) is included within the precision interval. Reliability is the complement of alpha risk.

<sup>16</sup>See Kinney and Uecker, pp. 66-67, for a discussion concerning the use of Chebyshev's inequality as a statistical decision rule for ratio analysis techniques

the monthly fluctuation if the computed upper precision limit, at a pre-specified confidence level, equals or exceeds a material amount.

b. Materiality based decision rules, which also compare some precision interval with a material amount. The difference between this rule and rule (a) is that the reliability of the precision interval is not explicitly specified, nor is it mathematically used to develop the precision interval. A materiality based decision rule would be to investigate a time trend analysis if the change in the account balance between periods equals or exceeds a material amount. In this case, the change in the account balance represents the precision interval, which incorporates some implied level of confidence.

c. Judgement based decision rules, which signal investigations if the derived estimate exceeds some "reasonableness" range. These decision rules are usually applied to judgemental and traditional analytical techniques. For example, an auditor may compare a ratio based on the current years unaudited book value with a ratio based on the previous years audited values, investigating if the difference in ratios equals or exceeds ten percent. The reasonableness range of ten percent becomes both the precision interval and the comparison criterion, which incorporates some implied, but unspecified confidence level.

There has been little published empirical research on judgement based decision rules. Judgemental decision rules use a "reasonableness range" as determined by the auditor. There may exist some heuristics that are commonly used to establish such reasonableness ranges. It is likely that the heuristics used are also related to the basis for forming comparison criteria.

As noted earlier, the decision rule is the critical element

in the comparative analysis. Any variation in the performance of an analytical technique applied to a financial relationship will be a direct result of the decision rule. Analysis of the heuristics used to form judgemental decision rules can reveal some insights as to the effectiveness of analytical procedures used in practice. The need for information in this area suggests the following question.

Are there any judgement based decision rules, assuming intermediate levels of confidence, that are commonly used when judgemental and traditional analytical techniques are applied during an audit?

Two elements of information are intrinsic to a decision rule: (a) the basis for forming the comparison criterion, and (b) the basis for defining a significant fluctuation that signals further investigation and possible audit extensions.

An investigation criterion may be formed using previous years audited data, industry averages, or current years budget estimates. It is also possible to use the current years unaudited data. However, Kinney and Uecker [1982] suggest that such estimates will be anchored to the unaudited value, inducing bias in the criterion.<sup>17</sup> To gain insight on these possible associations, practicing auditors were asked to select the typical basis for forming comparison criteria for each financial relationship analyzed during an audit.<sup>18</sup>

With both statistical and materiality based decision rules, a materiality threshold may be used as the comparison criterion. The auditor must specify this materiality threshold. This requires

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<sup>17</sup>Kinney and Uecker, p. 66.

<sup>18</sup>See section II of Appendix C, Interview Guide. The results are presented in Chapter 4.

that the auditor estimate the overall amount which is material to the accounts, and allocate this amount to the individual accounts. Previous research indicates that there is not strong consensus on materiality thresholds that should be used or how they should be allocated. These results also show that actual thresholds will vary depending on the auditing environment.<sup>19</sup>

There are numerous techniques which may be used to allocate the amount considered material to the individual accounts. Elliott and Rogers [1972] suggest one technique which allocates the material amount consistent with the fundamental theorem for statistical decomposition of the variance of a sum. This technique has been applied in studies by Heimann and Chesley [1977], and Cushing, Searfoss and Randall [1979].<sup>20</sup> Since there do not appear to be any studies which indicate that this allocation technique is inferior to other allocation techniques, it will be used within this study.

A final concern with the various decision rules relates to the consistency of audit risk. First, the allowable ultimate risk (UR) must be established. UR is the risk that monetary errors

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<sup>19</sup>James R. Boatsman and Jack C. Robertson, "Policy-Capturing on Selected Materiality Judgements," The Accounting Review 49 (April 1974):342-52; Shane Moriarity and F. Hutton Barron, "Modeling the Materiality Judgements of Audit Partners," Journal of Accounting Research 14 (Autumn 1975):320-41; Idem, "A Judgement-Based Definition of Materiality," Journal of Accounting Research 17 (Supplement 1979):114-35; Lauren K. Newton, "The Risk Factor in Materiality Decisions," The Accounting Review 52 (January 1977):97-108; and Michael Firth, "Consensus Views and Judgement Models in Materiality Decisions," Accounting, Organizations and Society 4 (1979):283-95.

<sup>20</sup>Robert K. Elliott and John R. Rogers, "Relating Statistical Sampling to Audit Objectives," Journal of Accountancy, July 1972, pp.46-55; Stephen R. Heimann and George R. Chesley, "Audit Sample Sizes for Aggregated Statement Accounts," Journal of Accounting Research 15 (Spring 1977):193-206; and Barry E. Cushing, D. Gerald Searfoss, and Reed H. Randall, "Materiality Allocation in Audit Planning: A Feasibility Study," Journal of Accounting Research 17 (Supplement 1979):172-216.

exceeding a material amount may remain undetected in the financial account balances. It is assumed that the nonsampling portion of UR is negligible.

Elliott and Rogers [1972] suggest that UR should be maintained at five percent. SAS 39 also suggests that five percent would be a reasonable UR. A review of auditing literature reveals that UR ranges from high levels of one percent to low levels of ten percent. SAS 39 suggests that five percent appears to be an reasonable level of UR.<sup>21</sup>

The auditor's assessment of the risk that the internal accounting controls fail to detect material errors and allow such errors to enter the financial balances is termed IC. Four levels of IC are specified in SAS 39: (a) 0.10, (b) 0.30, (c) 0.50 and (d) 1.00. Since analytical review procedures are used when the IC risk is relatively low, a value of 0.30 will be used for IC in this study.

The allowable risk of incorrect acceptance for the substantive tests of details is termed TD. Auditing literature suggests that acceptable levels of TD range for 0.05 to 0.50.<sup>22</sup> Assuming that the auditor's objective in applying analytical review procedures is to reduce total audit costs, less reliance will be placed on substantive tests of details and more reliance placed on analytical review procedures. Thus, a value of 0.50 will be used of TD risk in this study.

AR is the allowable risk of incorrect acceptance for the

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<sup>21</sup>Elliott and Rogers, p. 53; David N. Ricchiute, Auditing Concepts and Standards (Cincinnati: South-Western Publishing Co., 1982), p. 311; Jack C. Robertson, Auditing (Dallas: Business Publications, 1976), p. 368; and AICPA, SAS 39, pp. 17-20.

<sup>22</sup>Elliott and Rogers, p. 50; Robertson, p. 364; and AICPA, SAS 39, p. 20.

analytical review procedures. AR can be derived from the above risks using the following relationship:

$$\begin{aligned} \text{AR} &= \text{UR} / (\text{IC} \times \text{TD}) \\ &= 0.05 / (0.3 \times 0.5) \\ &= .33. \end{aligned}$$

This analysis established the allowable type II error rate for analytical review procedures at thirty-three percent. The actual value used in this study is thirty-six percent, which corresponds to a value of IC risk at twenty-eight percent. This value of AR was calculated under different assumptions concerning IC and TD.

Once AR is defined, the problem becomes how to maintain the risk at similar levels across the judgemental, materiality-based, and statistical decision rules. For statistical decision rules, UR will be controlled at the intermediate level of five percent by using AR = .36 as the precision in the decision rule. The materiality-based and judgemental decision rules do not explicitly incorporate precision. The decision rules used in the analysis are assessed from practicing auditors under the specified condition of an intermediate level of audit risk. It is assumed that each decision rule suggested by the auditors incorporates a reliability level in the intermediate risk range such that overall UR will be maintained at five percent.

Given these assumptions, the decision rules used in this study should have consistent levels of audit risk. The third component in the analytical procedure set, the financial relationship analyzed, is now discussed.

#### Analyzed financial relationships

Both professional and academic literature have been reviewed to determine which financial accounts are recommended for analysis

during an audit. Two basic forms of analyzed financial relationships are identified: (a) individual accounts, and (b) specific account relationships expressed as a ratio. Since the literature applied to general audits, practicing auditors were used to validate that the financial relationships are also analyzed during typical audits of medium-sized manufacturing firms. The auditors were presented with a listing of the analyzed financial relationships and asked:<sup>23</sup>

1. Is this list representative of individual accounts (or account relationships) that you typically analyze during an audit of a medium-sized manufacturing firm?
2. On what percentage of audits do you analyze this individual account (or account relationship) and use the results in forming the audit opinion?

This completes the analysis of information needed concerning analytical review procedures. The next category of data sources to be discussed is that related to the nature of accounting errors.

#### Nature of Accounting Errors

Measuring the relative performance of alternative analytical procedures requires consistency in the reliability level associated with the alternative decision rules. Assuming that consistent reliability levels are maintained, the error rates are derived by evaluating the alternative analytical methods with respect to the number of months in which investigations are signalled versus the number of months in which investigations are actually required. The number of months requiring investigation is a control parameter.

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<sup>23</sup>See section II of appendix C, Interview Guide. The results are presented in chapter 4.

The investigation requirements are controlled through models of the accounting information system. This accounting model assumes an error-free set of financial data. Whether an investigation is required is controlled through seeding errors into the financial data set. When the total amount of error seeded into the accounts is less than a material amount, no investigations are required. Investigations are required when the total error seed equals or exceeds a material amount.

The desire to maintain a realistic audit setting impacts this control procedure. Realism is enhanced through the use of financial relationships from actual firms to form the basis for the accounting models. Realism is also enhanced by ensuring that the rate and distribution of the monetary errors seeded into the financial data are representative of errors actually found in practice.

Research on the nature of accounting errors is limited. The existing studies analyze the nature of errors in audited financial data, showing the distribution of errors discovered by applied auditing procedures. Since these results are not independent of the audit procedures, they should not be used as a basis for comparison. Also, these studies may not include all potential errors. They include only those errors detected during an audit with the audit procedures applied.

A comparative analysis of auditing procedures should consider all potential errors. Rather than rely on the rates and distributions of errors detected by auditing procedures, this study will attempt to establish the nature of accounting errors through analysis of the origin of monetary errors.

Potential sources of monetary errors

Assuming that errors are not inherent in an accounting system with an adequate system of internal controls, monetary errors will originate during the processing of transactions. Deviations in the processing tasks increase the risk that a monetary error will enter the financial data. Such deviations become potential sources of monetary error. If the potential sources of monetary error are identified, then the likelihood that a monetary error would result and the distribution with which the monetary error would enter the monthly financial account balances can be assessed.

A monetary error can result from an accounting error or an accounting irregularity. The term "accounting error" refers to unintentional mistakes while "accounting irregularity" refers to intentional distortions of the financial statements. Since this study involves a transaction based accounting model, the sources of accounting errors and irregularities are dependent upon the transactions which are processed. So the first step in this process requires identification of all the pertinent transactions for a medium-sized manufacturing firm.

Professional and academic literature suggest the cycle approach as a common way to partition audit tasks while keeping closely related types of transactions and accounts in the same segment. Transaction cycles for the specific industry, and the transactions within the cycle, were identified using available audit guides from CPA firms and leading auditing textbooks.<sup>24</sup>

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<sup>24</sup>Arthur Andersen & Co., A Guide for Studying and Evaluating Internal Accounting Controls (1978), pp. 14-33; Price, Waterhouse & Co., The Business Approach to Auditing 1 (1980):25-32; Touche Ross & Co., The Touche Ross Audit Process Manual (1978), pp. 1-15; Arens and Loebbecke, Auditing, pp. 214-15; and Ricchiute, pp. 234-39.

These references provide differing opinions as to the exact structure and contents of the cycles. The cycles were chosen to insure that all potential transaction types are identified and categorized. A potential transaction type is one which supports the operating activities of the manufacturing firm and may be tested during an audit using analytical review procedures. For example, one potential transaction is the purchase of treasury stock. In a medium-sized manufacturing firm, the number of transactions of this type would be small, and each may be considered material. Efficient audit planning would dictate the use of direct tests of transactions and balances for this type of transaction. Hence, transactions involving the purchase of treasury stock would not be included in this analysis.

The potential transactions within each cycle were identified by analyzing the operations of a medium-sized manufacturing firm.<sup>25</sup> Auditing textbooks and published materials from national CPA firms included descriptions of a typical manufacturing process. Transactions were associated with each major accounting task within the manufacturing process.

The next step was to identify the potential sources of accounting errors and irregularities which could result from each transaction. This was accomplished by analyzing each transaction with respect to common types of accounting errors. Arens and Loebbecke identify seven types of errors which could occur when internal controls are not effective. These error types are: (a) invalid, illegal or duplicate transactions, (b) unauthorized transactions, (c) omitted transactions, (d) incorrect valuation,

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<sup>25</sup>See Arens and Loebbecke, Auditing, for a description of a medium-sized manufacturing firm.

(e) improper classification, (f) improper timing, and (g) incorrect footing and posting.<sup>26</sup>

This author contends that monetary accounting errors do not result from business risks associated with authorizations, approvals, substandard quality of products, etc. Such business risks may result in another source of error which, in turn, produces a monetary error. As an example, assume that a change in pay rate of an employee was not authorized. The monetary error is caused by calculating the employees wages at the wrong rate. Likewise, credit sales to unauthorized customers is not a monetary error. A monetary error could result if the account becomes uncollectible and is not written off as a bad debt.

The remaining six error types were used to evaluate each identified transaction and ascertain whether a monetary error could result. The circumstances when a monetary error could occur were listed as potential sources of errors and irregularities. A detailed listing of the business cycles, pertinent transactions, and potential sources is included in section III of Appendix C, Interview Guide.

Since the listing was generated from a variety of sources, it is necessary to validate that it is representative of a medium-sized manufacturing firm. The validation process is described in Chapter 4, Collection of Information.

Once the potential sources of accounting error and irregularity are defined, the rate at which the monetary errors result must be assessed. Previous studies on accounting errors have investigated the rates and distributions of the errors within financial accounts. These studies generally look at a population

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<sup>26</sup>Ibid., pp. 263-64.

of account balances for a company, such as accounts receivable. A sample of these accounts from the population would be investigated for errors. An error is defined as the difference between the book value and the audit value of the individual account. The overall error rate is derived from the number of errors found in the sample, while the distribution of the errors shows the frequency with which the various dollar amounts of monetary error occurs.

Within this study, the error rate is defined differently. This difference relates to the distinction between a detailed test and analytical review. In a detailed test, each individual account in the sample is investigated. If the aggregate of individual errors is deemed material, then additional audit actions may be taken. In analytical review, the population of accounts is analyzed to see if material fluctuations have occurred. If so, then additional investigations or audit extensions are performed to explain the fluctuation.

Thus, analytical review concerns the likelihood that the aggregated errors within the population of account balances are material. The material error rate is the likelihood that a material monetary error will result from a potential source of accounting errors and irregularities. Since analytical review looks at the population of account balances, the material error rate is expressed in terms of the number of audits performed. For example, a potential source of monetary error<sup>27</sup> may be expected to result in a material monetary error in five percent of all audits of medium-sized manufacturing firms.

The material error rate for a potential source of monetary

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<sup>27</sup>The term "potential source of monetary error" is used interchangeably with the term "potential source of accounting errors and irregularities."

error is derived from two separate events: (a) the likelihood that the potential source causes a monetary error in the associated financial accounts, and (b) the likelihood that the impact of this monetary error exceeds a material amount.

There are two ways that a single potential source of monetary error could result in a material monetary error. The first is the most obvious and occurs when the aggregate of the monetary errors resulting from the single source is material. But it is also possible that the potential sources are related. Discovery of a monetary error resulting from one source may indicate that monetary errors are also present due to another related source. Take the case where a single individual commits compliance deviations. These deviations could occur in all the processing tasks accomplished by that individual. Although the aggregate monetary error resulting from deviations in a specific processing task may not be material, the impact from all deviations in processing tasks could exceed a material amount.

Practicing auditors will be used to assess these likelihood estimates. The actual assessment technique is discussed in the next chapter. The following specific research questions relate to the assessment of the material monetary error rate for each of the potential sources of monetary error:<sup>28</sup>

1. In your opinion, on what percentage of all audits would you expect this type of error to occur (including errors which occur but are not discovered by audit procedures)?
2. When such errors do occur during an audit, on what percentage of those audits would you expect the amount of such errors to be: (a) material by themselves, and (b) material when aggregated with other related types of errors?

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<sup>28</sup>See section III of Appendix C, Interview Guide. The results are presented in Chapter 4, Collection of Information.

### Distribution of monetary errors

Assuming that the potential sources of monetary error and the expected frequency of audits in which material errors result have been defined, the financial accounts affected by the monetary error can be derived. To seed the monthly financial account balances with the resulting monetary error, knowledge must be obtained as to when the monetary errors enter the monthly balances.

There are numerous monthly distributions which could occur. Hylas and Ashton [1980] investigate the cause of errors which were detected during audits. These causes and the resulting error rates are summarized in Table 2. Analysis of these causes will provide some insight on potential error conditions which should be considered.

The results of the Hylas and Ashton study indicated that personnel problems and insufficient accounting knowledge encompassed approximately 36 percent of the errors found. It is speculated that these types of errors would tend to be consistent throughout the period, or would be concentrated into few months (as when new employees are trained, or during vacation periods).

The use of judgement in estimating certain items caused approximately 15 percent of the errors. Judgement errors would typically be involved with infrequent accounting events. Thus, it is speculated that most judgement-caused errors would be concentrated in a few months.

Cutoff or accrual procedures were attributed with causing approximately 38 percent of the errors. Such errors would tend to occur during the end of the audit periods. This could also include the end of interim periods when interim financial statements are

TABLE 2  
SOURCE AND RATE OF MATERIAL MONETARY ERRORS

Source of Error	Error Rate
Personnel problems and insufficient accounting knowledge. . . . .	36
Judgmental estimates . . . . .	15
Cutoff and accrual errors . . . . .	38
Mechanical . . . . .	12
Inadequate control, follow-up or review procedures. . . . .	9
Miscellaneous . . . . .	19

NOTE: More than one factor was associated with some errors, resulting in the total error rate exceeding 100 percent.

ADAPTED FROM: Robert E. Hylas and Robert H. Ashton, "Audit Detection of Financial Statement Errors," (New York University, 1980).

published.

Mechanical errors were found to cause approximately 12 percent of the errors. Mechanical errors would probably be random in nature. Since the employees causing these errors are considered normally to be competent and conscientious, it is expected that the errors would be evenly distributed throughout the year.

Approximately nine percent of the errors were attributed to inadequate control, follow-up or review procedures. It is expected that these types of errors would be either infrequent, occurring in only a few months, or consistent throughout the audit year.

Finally, miscellaneous causes composed approximately 19 percent of the errors. These errors tended to be infrequent and unusual in nature.<sup>29</sup> Hence, miscellaneous errors are expected to be isolated to a few months.

Using the above analysis, four error conditions are suggested:

- a. The entire monetary error occurs in a single month.
- b. The monetary error occurs at the end of each interim period. One fourth of the aggregate error is distributed into each end-of-interim-period balance.<sup>30</sup> This error condition is representative of consistent cutoff errors throughout the year.
- c. The monetary error occurs evenly throughout the

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<sup>29</sup>Hylas and Ashton, pp. 10-12.

<sup>30</sup>The even distribution of the error across months is the worst case situation. It should be easier to detect errors when the total amount occurs in a single month. The fluctuation in that single month as compared to other months should be more pronounced. If the error is distributed proportionately to the months, the fluctuations in a single month would be less pronounced. This assumes that the monthly fluctuations are relatively stable. If excessive fluctuations occur in the monthly balances, it becomes difficult to distinguish normal fluctuations from error-caused fluctuations.

period. One-twelfth of the error is distributed into each month. This error condition is expected to be the most difficult to detect using analytical review procedures due to the uniform occurrence of the monetary errors. It is representative of those errors which occur frequently and consistently throughout the audit year.

d. The monetary error occurs with no specific pattern. The number of possible monthly distributions is large. The possibilities go beyond even proportions distributed across the months. The error may be distributed with one-twelfth in each of two months, and five-sixths in another month. This study will consider three error conditions which distribute the monetary error with even proportions in any two, three, or four random months. These error conditions represent the worst case situation when errors are isolated into a few months during the audit period.<sup>31</sup>

e. A fifth error condition could result if significant seasonal variations occur in the operations of the firm. Seasonally related factors could also increase the risk of compliance deviations, resulting in increased risk of monetary error. For example, temporary employees could perform the tasks of vacationing employees during the summer. This fifth error condition results when the total monetary error occurs in a few consecutive months. This error condition will be represented with the total error evenly dispersed across a single quarter. Again, even dispersement implies the worst case situation.

There is no empirical evidence which relates these five error

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<sup>31</sup>Other studies have used various random error conditions. Collins used three and four randomly selected months. Kinney and Salamon used one and three randomly selected months in their study "Effect of Measurement Error," and two, four and six randomly selected months in their study "Alternative Investigation Rules."

conditions to the sources of monetary error. The opinions of practicing auditors will be used to gain some insight on these possible relationships. Specifically, for each of the potential sources of monetary error, auditors will be asked:<sup>32</sup>

When such errors do occur during an audit, on what percentage of audits would you expect the distribution of the monetary error over time to be:

- a. All in a single month?
- b. All at the end of interim periods?
- c. Evenly dispersed throughout the year?
- d. With no specific pattern?
- e. All in a single quarter?

#### Largest expected error size

Another item of information which is needed to adequately compare alternative procedure sets is the range of error size over which the procedure should be effective. As the size of the aggregate error in the financial data increases, the relative performance of the alternative analytical procedures may vary. Expectations of the largest monetary error within a financial account would establish the effectiveness range for the analytical procedure applied to that account.

The largest monetary error could result from either an accounting error or an accounting irregularity. It is expected that the size of accounting errors is different than the size of accounting irregularities. Arens and Loebbecke assert that it is more difficult to detect irregularities due to their concealment.<sup>33</sup> Monetary error sources which could result in material irregularities may require different audit procedures. Thus, it is

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<sup>32</sup>See section III of Appendix C, Interview Guide. The results are presented in Chapter 4, Collection of Information.

<sup>33</sup>Arens and Loebbecke, Auditing, p. 156.

necessary to distinguish between the largest expected accounting error and the largest expected accounting irregularity.

For each potential source of monetary error, practicing auditors will be asked:<sup>34</sup>

In your experience, what percentage of net income before tax best represents:

- a. The largest error of this type that you would expect to find?
- b. The largest irregularity of this type that you would expect to find?

This concludes analysis of the nature of accounting errors. From this analysis, research questions relating to the source, distribution, and size of monetary errors were developed. The next section relates the potential sources of monetary errors to the financial relationships included in the analytical procedure sets and the financial accounts in the financial data base.

#### Development of Affected Account Sets

A general accounting model for a medium-sized manufacturing firm is used as the basis for developing affected account sets. An affected account set shows the interrelationships between the potential sources of monetary errors, the financial accounts which are directly affected by the resulting monetary errors, and the financial relationships which analyze accounts directly or indirectly affected. The primary key for an affected account set is based on the financial accounts directly affected. Secondary keys are used to link the financial accounts to the one or more monetary error sources and the one or more financial relationships.

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<sup>34</sup>See section I of appendix C, Interview Guide. The results are presented in chapter 4, Collection of Information.

The development of the affected account sets included the following steps:

- a. Identifying the financial accounts directly affected by the potential sources of monetary error.
- b. Determining whether the errors' impact was permanent or temporary in nature. Once a permanent error enters a monthly financial balance, it appears in each subsequent monthly balance up to and including the end-of-year balance (assuming cumulative monthly balances are maintained). A temporary error will reverse its financial impact within the current audit period, and will not alter the end-of-year balances. The financial impact is isolated to those months in which the error occurs. For example, a cutoff error at the end of the first quarter may overstate the account in March, followed by a corresponding understatement in April. The net effect is that the error only appears in the financial balances for March. For temporary errors, it is necessary to assess the time lapse for the reversal process.
- c. Determining whether the error would result in an understatement or overstatement of the monthly financial balances. For some errors, the impact on the financial balance of an account could be in either direction. These types of errors are treated as two separate error sources, one resulting in an understatement and the other resulting in an overstatement. The scope of this study is limited, and does not address the perplexing problem of concurrently analyzing both understatement and overstatement errors.

The results of the analysis described above are presented in Appendix A. Review of these results reveal certain relationships among the financial accounts. For a financial account, there are two possibilities for the duration of the error (permanent versus

temporary) and two possibilities for the direction of the error (overstatement versus understatement). Thus, each financial account can be impacted in four ways: (a) a permanent understatement, (b) a permanent overstatement, (c) a temporary understatement, and (d) a temporary overstatement.

Most potential sources influence either two or four financial accounts.<sup>35</sup> Also, the duration of a temporary error resulting from a potential source is the same for each of the affected accounts. Hence, logical groupings are formed of pairs of affected financial accounts. Further investigation shows that each logical grouping describes the impact of one or more potential sources of error. Each specific account relationship within a logical grouping defines the financial accounts affected by an error and the direction and duration of the error, thereby uniquely defining the subsequent impact of a potential source of monetary error on the financial data base. These account relationships are presented in Appendix B.

The use of affected account sets reduces the number of monetary error sources which must be evaluated. Numerous error sources may induce similiar impacts on the financial accounts. Analysis of the affected accounts should provide results that are representative of all potential sources that produce the relationship. The only variation in such results would be due to the sensitivity of the analytical methods to the size of the monetary error.

This completes the description of the financial data base and

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<sup>35</sup>Situations where only one financial account was influenced (see error source #32 in Appendix A) will typically result in an out-of-balance condition in the financial accounts. It is assumed that adequate internal control procedures are in effect to detect and correct such situations.

discussions of the information requirements for the data sources. All of these components provide information which is necessary for the operation of the simulation model.

#### Analysis of Simulation Model

The functions performed within each simulation process depicted in Figure 1 (presented earlier) are integrated with the data sources and data bases. The simulation model is iterative. The first four processes are essentially nested loops. This iterative sequence allows the simulation model to automatically cycle through the various stages of the process. The end result is that each analytical procedure is applied to each of the four financial data sets in the financial data base for each level of error size and error distribution. The iterative process is further explained in the following discussion.

#### Selection of monetary errors

The first simulation process involves selection of the sources of monetary errors according to their rate of occurrence. In this manner, those monetary error sources which have the greatest likelihood of impacting the financial accounts will be analyzed. As discussed previously, analysis of all monetary error sources would be redundant since some monetary error sources have identical affects on the financial data base.

The data source file containing monetary error sources is ordered by the likelihood that a monetary error will result and that the monetary error will be material. Sequential access to the data source file ensures that monetary error sources enter the simulation model in the proper sequence.

### Determination of affected accounts

The second process in the simulation model involves selecting the financial accounts affected by the potential sources of accounting errors and irregularities. Since the data source file of affected account sets can be accessed by monetary error source, this process is relatively simple. The monetary error source identified in the first process is used to retrieve the affected account set. If the affected account set has not been previously used in the simulation process, the affected financial accounts and financial relationships are transferred into the model. If the affected account set has already been used, the simulation model returns to the first process and retrieves the next monetary error source from the sequential file.

### Seeding monetary errors

The third process in the simulation model involves seeding the financial account balances with monetary errors. Two information files are required in this process: (a) the monthly distribution of monetary errors, and (b) the financial data base. The only additional information needed is the size of the monetary error to seed into the monthly financial account balances.

A control parameter in the simulation model regulates the occurrence of non-material versus material errors. A non-material error can vary in size from zero to the materiality threshold. Material errors begin at the materiality threshold and vary in size up to the largest error which could occur for the account (assuming that the largest error exceeds a material amount). Thus, the materiality thresholds for each individual account must be determined.

Account materiality thresholds are obtained by allocating the total amount considered material for the firm. Selection of the allocation technique is purely arbitrary. The specific allocation technique used in this study is based on the approach developed by Elliott and Rogers [1972].<sup>36</sup> The squared value of the materiality construct for the firm is allocated in proportion to the total dollar amount within each account. The square root of this amount becomes the account materiality threshold. The allocation method ensures that the square root of the sum of the squared account materiality thresholds equals the aggregate materiality construct.

There are two materiality constructs which are needed for the allocation process. The first, based on net income before tax, is used to allocate materiality thresholds to income statement accounts. It does not seem appropriate to base the materiality thresholds for balance sheet accounts on net income since most balance sheet accounts are not related to net income. Thus, a materiality construct based on total assets is used to allocate materiality thresholds to balance sheet accounts.

The general rules defined in the literature for defining aggregate materiality constructs may not be appropriate for medium-sized manufacturing firms. Additionally, these constructs are expressed in terms of net income, and are considered inappropriate for balance sheet accounts. Thus, estimates of the materiality constructs for medium-sized manufacturing firms must be assessed from practicing auditors. This leads to the following research question:<sup>37</sup>

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<sup>36</sup>Elliott and Rogers, p. 53.

<sup>37</sup>See section I of Appendix C, Interview Guide. The results are presented in Chapter 4, Collection of Information.

What monetary amount is normally considered material for medium-sized manufacturing firms, expressed in terms of both net income before tax and total assets?

Within the error seeding process, the sizes of both non-material and material errors must be established. For non-material errors, the monetary amount seeded into the financial account balances will be 0.0, 0.5, and 0.8 times the account materiality threshold. Material errors will be seeded at 1.0, 1.5, and 2.0 times the account materiality threshold.<sup>38</sup>

The use of three points within each error range will allow assessment of the sensitivity of the alternative analytical techniques. Additionally, this wider range of error may enhance the generalizability of the results. To apply the results of the comparative analysis to other data sets, the relationship between the size of the monetary error in the account and the account balance must be analogous. The inclusion of additional error amounts produces performance data for more error-size/account-balance relationships.

The affected account set to be seeded consists of two separate financial accounts. The materiality threshold allocated to these accounts will only be the same if the account balances are the same. However, the amount of monetary error seeded into the accounts should be equal. The monetary errors result from deviations in the processing of accounting transactions. These accounting transactions are based on the double-entry system. Thus, the errors in the accounts must be equal or an out-of-balance situation will exist. It is assumed that internal accounting

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<sup>38</sup>Kinney and Salamon, "Alternative Investigation Rules," varied the error size using 0.5, 1.0, and 1.5 times the materiality threshold.

controls will detect and correct out-of-balance situations.

The calculated amount of monetary error to be seeded into the financial accounts will be based on the smallest materiality threshold of the two related accounts. This calculated amount will be seeded into all financial accounts directly and indirectly affected by the monetary error source, according to the derived duration and direction of error. For example, the monetary error source "goods shipped but not invoiced" will understate both gross sales and accounts receivable. An error in gross sales would also be present in net sales, gross profit, operating income, and net income. An error in accounts receivable would also be present in current assets, total assets, and working capital.

Each of the four financial data sets in the financial data base are seeded with monetary errors. For each financial data set, both the error size and monthly distributions are varied. The following iterations of monthly distributions result for each error size:<sup>39</sup>

- a. The total error is seeded in each single month (January to December) of the current audit period, producing 12 iterations.
- b. One-fourth of the error is seeded into March, June, September, and December for one iteration.
- c. One-twelfth of the error is seeded into each single month for one iteration.
- d. One-half of the error is seeded into each of two randomly selected months. This procedure is repeated three times producing three iterations.

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<sup>39</sup>The error condition corresponding to seasonal variations did not occur with enough frequency to warrant simulations. See Chapter 4.

e. One-third of the error is seeded into each of three randomly selected months. Again, three iterations are produced.

f. One-fourth of the error is seeded into each of four randomly selected months for three iterations.

The affected months for the monthly distributions corresponding to the error condition of no specific pattern (d, e and f) are selected on a random basis. It is possible that the actual months selected will influence the results due to normal monthly variations in the data. To reduce these effects, each iteration involving randomly selected months is repeated three times.

In total, 23 monthly distributions are seeded with each of the five error sizes resulting in 116 different simulation data sets (115 seeded with errors plus one with no errors seeded).

This completes the description of the process of seeding monetary errors into the financial data set. The next process applies each alternative analytical method to the seeded data set and evaluates the type I and type II error rates.

#### Evaluate alternative analytical procedures

Using the seeded financial data base, the type I and type II error rates are evaluated for alternative analytical procedure sets. A procedure set is defined as containing an financial relationship, an analytical technique applied to the financial relationship, and the decision rule used to signal investigations. The evaluation process only looks at two analytical techniques, traditional analysis and regression analysis.

From the traditional techniques and decision rules identified by practicing auditors, three combinations of analytical technique/decision rule are evaluated. Only one regressive technique will be

evaluated. The regression technique uses the decision rule developed by Deloitte, Haskins and Sells, and is applied in a simple linear model to the analyzed financial relationships and as a time series for individual accounts.

There are three potential cutoff points for each combination of analytical technique and decision rule. The combinations can be applied to the cumulative financial balances in the last month of the current audit period. This cutoff point represents testing at the end of the audit period. Auditors may also perform interim tests of the cumulative financial balances. An example of an interim cutoff point would be testing at the end of September in a current audit period that ends in December. Finally, testing may be conducted on a monthly basis. The advantage of this approach is that the auditor can perform the monthly tests anytime after the end of the month. Where possible, each of the combinations of analytical technique and decision rule will be evaluated at each of the three cutoff points.<sup>40</sup>

One comparison criterion for the decision rules used in the study is the monthly account materiality threshold. The arbitrary allocation process allocates a yearly account materiality threshold based on the cumulative balance in the financial account as of the end of the current audit period (December 31st in this study). If it is known that the total monetary error is evenly distributed in all twelve months, then one-twelfth of the yearly materiality threshold should be used as the comparison basis for monthly evaluations of income statement accounts. For income statement

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<sup>40</sup>Certain analytical techniques are not applied to the cumulative financial balances. Thus, point-in-time cutoff tests may not be appropriate for all the analytical procedures included in the simulation process. The discussion here is oriented toward the maximum number of observations which may occur.

accounts which are evaluated based on the cumulative balance from the beginning of the year, the monthly materiality thresholds should also be cumulative. Thus, the comparison basis for a September interim cutoff test would be nine-twelfths of the yearly account materiality threshold.

The monthly balances in the balances sheet accounts are not cumulative. Thus, the yearly account materiality threshold based on the end-of-period balance is used as the comparison criterion.

Since the monthly distributions of the monetary errors are known within the simulation model, the monthly account materiality thresholds will be allocated based on this knowledge. For example, when the total error is distributed into four months, one-fourth of the yearly account materiality threshold will be used as the comparison basis for each month.

Each monetary error source can affect numerous financial relationships, and each financial relationship can be affected by numerous monetary error sources. As an example, Table 3 shows some hypothetical associations between error sources and financial relationships. Error source (1) affects financial relationships (a), (b), (c) and (e). Financial relationship (a) is affected by error sources (1) and (3). A complete analysis of the effects of the error sources listed in Table 3 would require 18 evaluations of the financial relationships (three for (a), four for (b), three for (c) and (d), and five for (e)). If the number of error sources is increased to 106 and the number of financial relationships is increased to 32, the total number of evaluations of financial relationships becomes quite large.

To limit the number of simulations, only three evaluations will be allowed for each financial relationship. Since redundant effects were eliminated in the first simulation process, each

TABLE 3

HYPOTHETICAL ASSOCIATIONS BETWEEN ERROR  
SOURCES AND FINANCIAL RELATIONSHIPS

Error Sources Affecting Financial Relationships	Financial Relationships				
	a	b	c	d	e
1	x	x	x		x
2		x	x	x	x
3	x		x	x	x
4		x			x
5	x	x			x

financial relationship reflects a different erroneous state of the financial data base.

In summary, four combinations of analytical techniques and decision rules may be applied to each analyzed financial relationship at three different cutoff points. In total, thirty-two financial relationships are included in the study (from Chapter 4), resulting in 128 analytical procedure sets. Each analytical procedure set is applied to three different simulation data sets, each seeded with the monetary error resulting from a different monetary error source. This produces three measurements for each of the 128 analytical procedure sets applied at each of three cutoff points.

Each simulation data set reflects 116 different error states by varying error size and monthly distributions. In addition, there are four separate financial data sets contained in the financial data base, two time periods for each of two firms. Thus, there is a potential of having 464 versions of the financial statements.

Another function of this fourth simulation process (evaluating alternative analytical procedures) is to tabulate the resulting type I and type II error rates according to the financial data set used (4), test cutoff point (3), error size (6), error distributions (6), financial relationship analyzed (32), analytical technique/decision rule combination (4), and error source used as the basis for seeding the monetary error (3). The combinations of the control parameters ( $4 \times 3 \times 6 \times 6 \times 32 \times 4 \times 3$ ) results in 165,888 measurements of type I error rates and 165,888 measurements of type II error rates. Note that some aggregation has taken place. Specifically, the 23 error conditions are aggregated into the 6 error distributions. The error rates for these aggregated

categories are still derived by dividing the number of errors by the number of observations. These tabulated results are stored in the error rate data base, and form the input to the comparative analysis process.

#### Comparison of alternative procedures

The main control parameters in the simulation model are the error size, error distribution, test cutoff point, and financial data set. The objective of this process is to compare the relative efficiency (type I error rate) of alternative analytical procedure sets for a specified level of effectiveness. (type II error rate).

With respect to performance, the critical element in a procedure set is the decision rule. The decision rule incorporates both the precision and reliability associated with the procedure set. Thus, the relative efficiency of the alternative decision rules which meet a specified level of effectiveness will be compared while controlling the account relationships and analytical techniques.

But there is also another way to compare procedure sets. A monetary error source will impact two or more financial accounts. One or both of these affected accounts may be included in numerous financial relationships which are typically analyzed.

A reference to Appendix B illustrates this point. The monetary error source "goods shipped but not invoiced" understates both gross sales and accounts receivable, as reflected in relationship #11 in Appendix B. Twenty-six financial relationships are listed which could be analyzed to detect the error resulting from the monetary error source. Thus, it is also necessary to compare the relative efficiency of alternative financial relationships which meet a specified level of effectiveness while

controlling the analytical technique and the decision rule.

Another item of information which should be considered in the comparison process is the size of the largest expected monetary error resulting from each potential source. In the next chapter, the size of the largest expected monetary error for each potential error source is assessed from practicing auditors. The assessments distinguish accounting errors from accounting irregularities. In most audit situations, an auditor is only looking for accounting errors in the financial data. If the auditor suspects irregularities, the audit program may be expanded to detect them. In such situations, information is needed on the ability of analytical review procedures to detect irregularities.

It is expected that as the size of the monetary error increases, the errors become easier to detect, requiring less effective procedures. Conversely, detection of small material errors (the aggregate error within a single account equal to a material amount) should be more difficult requiring more effective procedures. If the maximum size of the monetary error resulting from a potential source is equal to a material amount, then only the most effective audit procedures should be applied to detect that monetary error. If the maximum size of the monetary error is greater than a material amount, then less effective audit procedures may be applied.

For specified levels of effectiveness, the relative efficiency of the analytical procedures is established. Selection guidelines are developed based on those procedures which are the most efficient at the specified effectiveness. The selection guidelines relate the sources of monetary errors to the analytical procedures which are capable of detecting them. For a given combination of monetary error sources which are expected during an

audit, an auditor may select the most efficient analytical procedures.

#### Summary

A research approach for the development of selection guidelines for analytical review procedures has been presented. The research approach is based on a simulation model which will be used to perform a comparative analysis of alternative analytical procedures.

The comparison criteria are the type I and type II error rates. The type II error rates are used to select those analytical procedures which meet a specified level of effectiveness. Of those procedures, the type I error rate is used to establish the relative efficiency.

The simulation model involves five major processes. Each process requires information external to the model, some of which must be derived empirically. These processes, and the specific information needs, are:

a. Selection of monetary error sources by the likelihood that a material monetary error will result in the financial account balances. This process requires empirical information which defines the potential sources of monetary error and the respective material error rates.

b. Determination of the financial account balances affected by each monetary error source. This process requires information concerning the direction and duration of the monetary errors.

c. Seeding monetary errors into financial data sets, which requires information concerning the monthly patterns by which the monetary error sources enter the monthly financial balances and

the size of the monetary error.

d. Application of alternative analytical procedures.

This process requires empirical information which defines the analytical review techniques normally applied during an audit, the financial relationships to which they are applied, and the decision rules used to identify significant fluctuations.

e. Comparative analysis of the relative efficiency of the analytical procedures, for a specified level of effectiveness.

## CHAPTER 4

### COLLECTION AND ANALYSIS OF INFORMATION

#### Introduction

The previous chapter defined specific information which must be collected to support the comparative analysis of analytical procedures. There are two potential sources from which the information can be collected: (a) extraction from existing auditor records, and (b) assessment from experienced auditors.

Extraction from existing records is not a viable alternative. Many of the specific research questions arose due to the lack of available, documented information. The rates and monthly distributions of the monetary errors could be derived from audit workpapers. However, this form of analysis would be incomplete since it identifies only those errors detected by the applied auditing procedures. Additionally, it would not be feasible to review the audit workpapers of a sufficient number of firms to allow generalization to the manufacturing industry.

The approach used in this study is to obtain the required information from assessments by experienced auditors using a group assessment technique. This chapter will define the extent and content of the survey population and the collection strategy applied to the resulting sample. The survey data will be analyzed in three sections: (a) materiality thresholds for the manufacturing industry, (b) the nature of analytical review procedures, and (c)

the nature of monetary errors. For each of these sections, the results of the survey will be summarized and analyzed, and integrated into the simulation model described in Chapter 3. Finally, the associations between the financial relationships and sources of monetary errors will be analyzed, and the implications of these associations presented.

#### Survey Population and Sample

The population for the study consists of experienced auditors with indepth knowledge of the auditing processes applied to medium-sized manufacturing firms. The actual survey population is restricted to partners and managers in two Big Eight public accounting firms within four geographical areas. It is assumed that a population of experienced auditors comprises partners and managers of public accounting firms. The choice of the number of audit firms and geographical areas was based on the following considerations:

a. The use of multiple geographical areas increases the experience base of the population and reduces the potential biases which may result from varying economic conditions within any one geographical area. The four locations were selected on the basis of convenience, weighing the cost and time of travel against the extent of medium-sized manufacturing within the area.

b. The group assessment technique used in the study required ten to twelve participants. It was planned to obtain one to two participants from each of two firms with each of the geographical areas. The two firms selected both offered to support the research project.

Participants were selected from the survey population using a purposive selection form of model sampling. In each

geographical area, the managing partners of the local public accounting firm offices were contacted and asked to support the project. Supporting offices provided from one to three partners and managers who were considered to be the most representative of experienced manufacturing auditors.<sup>1</sup> This process identified fifteen participants, five from firm A and ten from firm B. Subsequent cancellations reduced the number of participants from firm A to three. The characteristics of the sample of auditors are presented in Tables 4 and 5.

Purposive sampling was used since random probability sampling was impractical. Development of a sampling frame would require obtaining the names of experts in the manufacturing industry from each of the national public accounting firms. Even if a sampling frame could be developed, it is unlikely that all individuals selected from the frame would be able to participate. The availability of partners and managers in a public accounting firm is dependent on the extent of audit work currently required by their clients. For any given time period, some auditors within the sampling frame would not be available to participate in the study. If one of the selected auditors does not participate, then the assumptions for random probability sampling are not met, and the resulting bias is unknown.

Purposive sampling allows selection of a representative sample of audit partners and managers with minimum costs. The major drawback with the purposive selection technique is that no insight can be obtained mathematically concerning the reliability

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<sup>1</sup>Leslie Kish, *Survey Sampling* (New York: John Wiley & Sons, 1965), p. 18, defines model sampling as "...sampling based on broad assumptions about the distribution of the survey variables in the population." Forms of model sampling include: (a) fortuitous samples, such as volunteer subjects, (b) purposive samples where representative units are selected, and (c) quota sampling.

TABLE 4  
AUDIT EXPERIENCE OF SAMPLE

	Total	Average	Range
Years Experience ..	170	13	8 - 28
Number of audits ..	3,014	232	27 - 660
Number of medium sized manufact- uring audits . .	785	60	10 - 150

TABLE 5  
COMPOSITION OF SAMPLE

	Firm A	Firm B	Total
Location 1	1	2	3
Location 2		2	2
Location 3	1	3	4
Location 4	1	3	4
Total	3	10	13

of the resulting point estimates of the population parameters. This restriction results from the lack of random selection and the use of unequal probabilities of selection for each participant.

### Collection Strategy

#### Selection of assessment technique

The specific research technique used to collect the required information must be capable of providing accurate assessments from a group of experts. The nature of the research questions was a major consideration for selecting the assessment technique.

The research questions concerning the characteristics of monetary errors are similar in form to almanac studies.<sup>2</sup> A single, quantifiable answer to each of these questions does exist. Yet it is not feasible to derive the answers by direct investigation. Group assessment techniques can be applied to these questions to develop a consensus opinion of experts as an approximation to the answer. The Delphi method emerges as a viable group assessment technique.

Fusfeld and Foster performed a review of almanac studies which employed the Delphi method. They found that the responses converged towards the correct answer for the majority of the questions. The behavior of Delphi responses for almanac questions is summarized as follows:

- a. It has been found that average group error decreases with increases in group size, increases in self-ratings

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<sup>2</sup>An almanac study is defined as one where the answers to questions are known but obscure; for example, the number of tons of potatoes harvested in Idaho during a specific year.

of confidence, and decreases in the amount of dispersions among the respondents. The dispersions were found to correlate well with error when the self-ratings and group size are held constant. Likewise, the self-ratings were found to correlate well with error when the dispersions and group size are held constant. Hence, it is difficult to substantiate that group error depends on group size alone.

b. It has been found that the average group error drops rapidly as the number in the Delphi group is increased to about eight to twelve. After reaching a number of about thirteen to fifteen, the average group error decreases very little with each additional member. Fusfeld and Foster suggest a group size of ten to twelve.

c. One of the major problems in the Delphi technique arises in understanding the meaning of the distribution of estimates which have been obtained from the experts. It has been found that individuals tend to think in terms of ratios scales rather than linear scales. The distributions of responses are typically lognormal, with an equal number of responses between 1 and 10 as between 10 and 100 (assuming a range of 1 to 100).<sup>3</sup>

Other group assessment techniques cited in the literature may produce more consistent assessments than the Delphi method for given situations.<sup>4</sup> However, the Delphi method as been shown to be effective in reducing assessment variations for almanac studies.

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<sup>3</sup>Alan R. Fusfeld and Richard N. Foster, "The Delphi Technique: Survey and Comment," Business Horizons 14 (1971):63-74.

<sup>4</sup>David H. Gustafson, Ramesh K. Shukla, Andre Delbecq, and G. William Walster, "A Comparative Study of Differences in Subjective Likelihood Estimates Made by Individuals, Interacting Groups, Delphi Groups, and Nominal Groups," Organizational Behavior and Human Performance 9 (1973):280-91.

Additionally, most of the other group assessment methods require some form of interactive group process. The Delphi method has advantages in that the estimates can be gathered faster with less cost than through the use of traditional group meetings.<sup>5</sup>

The research questions concerning analytical review procedures are directed toward identifying the preferences of experienced auditors. There does not appear to be a single correct answer to these questions. The goal is to identify whether certain analytical methods are preferred by a majority or minority of the experts. Because the responses are based on individual preferences, variation is expected regardless of the assessment technique applied. Application of a Delphi-like method may not substantially reduce the variation, but should increase the validity of the estimates since they would be based on more than one measurement of the individual preferences.

The specific technique to be applied in this study is an estimate-feedback-estimate (EFE) method. This method is similar to a Delphi method with only two iterations. First, individual estimates are obtained from each expert. The initial estimates are aggregated and summarized, with the results returned to the experts as feedback. Using the additional knowledge derived from the feedback, the experts again make individual estimates. These subsequent estimates are aggregated to form the consensus opinion.

Although the results obtained from the EFE method may not represent a pure consensus opinion, empirical studies have shown that the use of feedback will reduce the variation among the

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<sup>5</sup>Fusfeld and Foster, pp. 63-74; and G. R. Chesley, "Elicitation of Subjective Probabilities: A Review," The Accounting Review 50 (April 1975):332-333.

individual estimates. Different points of view are brought out and balanced during the process, but good and bad estimates are given equal weight. Thus, the results achieved by applying the EFE method should represent a more consistent opinion than would be obtained using only the initial individual estimates. Although opinions are less satisfactory than hard facts, there is no alternative since the actual data is sparse.<sup>6</sup>

#### Assessment of auditors' estimates

Initial estimates. The strategy used to gather the estimates from practicing auditors must accurately measure the concept in question. Whether an instrument measures what it is supposed to measure is essentially a question of the epistemic correlation. Epistemic correlation represents the strength of the relationships between the conceptual and empirical levels. Measurement error exists if these relationships are less than perfect. The strength of the epistemic correlations may be assessed with content validation procedures (also termed face validation). Content validation is ultimately a matter of judgement. According to Bailey:

If the measure clearly measures another concept, then obviously it does not have face validity. However, if the item does not seem to be measuring any recognizable concept other than the one it is supposed to be measuring, the instrument can be said to have face validity."<sup>7</sup>

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<sup>6</sup>Norman Dalkey and Olaf Helmer, "An Experimental Application of the Delphi Method to the Use of Experts," Management Science 4 (April 1973):458-67; Fustfeld and Foster, pp. 69-73; and Gustafson, et al., pp. 287-91.

<sup>7</sup>Kenneth D. Bailey, Methods of Social Research (New York: The Free Press, 1978), p. 58.

The controllable element in the measurement process is the content validity of the questions. To exercise control of this element, a structured personal interview was selected as the data collection technique for the initial estimates. Such interviews follow the form of an objective questionnaire, yet allow clarification and elaboration on specific questions within narrow limits. This technique also ensures that complete information is obtained from all participants, eliminating non-response and non-collection biases.

Assuming that the questions have content validity, the accuracy of the measurement becomes dependent on the participants' ability to express his knowledge as a quantified value. Hence, the accuracy of the measurement is dependent on the technique used to elicit the individual estimates. These individual estimates are in the form of point estimates of the frequency of an event, expressed as a percentage. For analytical review procedures, the participants are asked to indicate the frequency with which they apply various analytical methods during audits of medium-sized manufacturing firms. For monetary error sources, the participants are asked to provide the observed frequencies of the events based on their knowledge of audits of medium-sized manufacturing firms.

Heuristics subconsciously used by the participants to aid them in forming their subjective assessments may introduce biases in the estimates. Tversky and Kahneman have demonstrated that three judgemental heuristics - representativeness, availability and anchoring - are commonly used in determining probabilistic judgements.

a. Representativeness results when likelihoods are assessed based on the degree of similiarity between a better known quantity and the quantity in question. When a high degree of

similarity exists, the assessed likelihoods are biased toward the better known quantities. The direction and amount of bias varies with each assessment.

b. Availability results when an event is judged likely or frequent because it is easier to imagine or recall. Instances of frequent events are typically easier to recall than instances of less frequent events. Availability is a valid cue for the assessment of frequencies. However, availability may also be affected by subtle factors unrelated to likelihoods such as familiarity and recency. Reliance on availability may result in systematic biases.

c. Anchoring is another heuristic which may introduce bias in the results. With anchoring, a natural starting point is used as a first approximation to the judgement. The anchor is then adjusted to accommodate the implications of additional information. In most situations, the adjustment is insufficient, producing bias in the estimates.<sup>8</sup>

The effects of the above heuristics are problem specific. The nature of the research questions in this study necessitates a high degree of reliance on availability. Hence, systematic biases in the assessments are likely. The assessments will tend to be based on the characteristics of analytical procedures and monetary errors associated with recently performed audits.

Biases resulting from anchoring and representativeness should be negligible for assessments concerning the use of analytical review procedures since it is assumed that experienced auditors can accurately determine the frequency and form of analytical methods

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<sup>8</sup>A. Tversky and D. Kahneman, "Judgement Under Uncertainty: Heuristics and Biases," Science 185 (1974):1124-31.

that they typically apply during an audit.

Biases in the assessments concerning the characteristics of monetary errors will be more pronounced. The auditors are asked to consider their total auditing experience with medium-sized manufacturing firms in assessing the likelihoods. For potential error sources which are less likely to occur, representativeness may be applied in determining the assessment. Also, assessments for related error sources are likely to be anchored to the initial assessment. In an effort to limit the effects of these heuristics, the following actions were taken:

a. Within each type of transaction, the potential sources of error were arranged to reduce the occurrence of sequential questions addressing the same error type. Within this study, errors are classified as cutoff, recording, classification, valuation and other types. This action minimizes the chance that related errors are in a sequential order, thereby limiting the application of the representativeness and anchoring heuristics.

b. The order of the transaction types was varied for each participant. Thus, no two participants completed the section on monetary errors with the same sequence of transaction types. This action minimizes the effects of systematic biases which result from the order of the questions.

The structured interview guide is presented in appendix C in three sections. Section I collects information pertaining to audit experience and assessments of the materiality thresholds for medium-sized manufacturing firms. Section II assesses information on the use of analytical review procedures typically applied during an audit of a medium-sized manufacturing firm. Information concerning the characteristics of monetary errors is assessed in section III.

The instrument was first pretested using faculty members with

audit experience. The objective of this pretest was to assess the relevance and wording of the questions and to insure that the introductory instructions were clear and concise. The structured interview guide was then administered to a practicing auditor in a local firm. The pretest individual was experienced in auditing medium-sized manufacturing firms. The pretest interview identified additional clarifications that were needed and provided an estimate of the time required to complete the interview.

The structured interview was administered to the participants over a three week period. Each interview lasted approximately three hours. The first task in both sections II and III was to validate the completeness of the listed information. Any additions to the list were incorporated into subsequent interviews. After the last interview was completed, telephone interviews were conducted with each participant to complete those items added after the initial interview. The lists presented in appendix C contain the complete set of items after all interviews.

Follow-up estimates. The follow-up estimates were assessed using a mailed questionnaire. Choice of this assessment method was based on the following considerations:

- a. As a result of the initial personal interviews, participants should be familiar with the concepts presented in the questionnaire. Thus, interpretation problems should be minimal.
- b. The response rate of the participants is expected to be high. Many of the participants developed an interest in the study during the initial interviews and should be willing to devote the additional time required to complete the questionnaire.
- c. The expense involved with the mailed questionnaire is substantially less than the expense of a follow-up interview.

The follow-up questionnaire was pretested among faculty members with previous auditing experience and a practicing auditor from a local public accounting firm. The final questionnaire, presented in Appendix D, was mailed to each of the thirteen participants. Response time for the returned questionnaires ranged from two weeks to three months.

### Summary

This concludes the discussion of the collection strategy. An estimate-feedback-estimate technique was chosen as the technique, using personal interviews for the initial estimates and a questionnaire for the follow-up estimates. Literature was cited which suggests that this technique should be a viable method to gather the information required for this study. In the next sections, the actual results obtained from applying this technique are discussed.

### Materiality Thresholds

One objective of the survey of practicing auditors was to establish the overall materiality thresholds for medium-sized firms within the manufacturing industry. The mean, median, mode and range of the materiality estimates are presented in Table 6. For both the net income and total asset basis, the mode represented six responses. The next highest frequency of responses was three 3s for the net income basis and three 10s for the total asset basis. The mode represents the value that is most commonly used by the participants and will be used within the simulation model to establish the overall materiality thresholds which will be allocated to individual accounts within the financial data sets.

TABLE 6  
MATERIALITY THRESHOLDS ASSESSED FROM  
PRACTICING AUDITORS

	Mean	Median	Mode	Range
Percentage of net income before tax	4.85	5	5	2 - 10
Percentage of total assets . . . . .	7.31	6	5	5 - 12

### Analytical Review Procedures

An analytical review procedure is composed of a financial relationship, an analytical technique and a decision rule. The survey results for each of these components will be presented and then the analytical procedures will be integrated into the simulation model.

#### Financial relationships

Initial estimates. The responses concerning the percentage of audits in which the various account relationships are applied are summarized in Table 7. For each financial relationship, Table 7 provides information concerning the percentage of participants who use it, the averaged percentage of audits in which it is employed, and the relative variation in the averaged percentages.

The data presented in Table 7 were first analyzed for the degree of concordance among the participants' responses concerning the use of the financial relationships. Kendall's coefficient of concordance was used to measure the degree of agreement among the participants. This is a non-parametric statistic which compares the similarities of the ranked preferences among the participants. A high degree of concordance indicates that the participants have similar preferences for the various financial relationships. If the resulting test statistic ( $W$ ) is close to one, the observed sets of rankings are in close agreement. When there is poor agreement among the sets of ranks,  $W$  will be close to zero.<sup>9</sup>

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<sup>9</sup>Wayne W. Daniel, Applied Nonparametric Statistics (Boston: Houghton Mifflin Co., 1978), pp. 326-31.

TABLE 7

## USE OF FINANCIAL RELATIONSHIPS DURING AN AUDIT

Financial Relationship	Percent of Participants Who Use this Financial Relationship	% of Audits in Which Employed	Relative Variation in Responses
Gross Margin Percentage . . . . .	100.00	97.31	.07
Net Sales / Total Assets . . . . .	46.15	25.77	1.52
Net Sales / Physical Production Volume . . . . .	46.15	28.85	1.43
Sales Discounts / Gross Sales . . . . .	61.54	46.92	1.00
Sales Returns and Allowances / Gross Sales . . . . .	61.54	43.46	1.05
Sales Commissions / Net Sales . . . . .	76.92	52.69	.78
Sales Taxes / Gross Sales . . . . .	30.77	17.31	2.14
Receivables Turnover . . . . .	100.00	66.15	.48
Number of days sales in accounts receivable . . . . .	92.31	62.69	.50
Change in cash / Change in receivables . . . . .	30.77	20.00	1.90
Allowance for Bad Debts / Receivables . . . . .	92.31	86.15	.37
Direct Materials / Cost of Sales . . . . .	84.62	67.31	.59
Direct Labor / Cost of Sales . . . . .	92.31	63.85	.63
Factory Overhead / Cost of Sales . . . . .	92.31	63.85	.63
Raw Materials Turnover . . . . .	92.31	60.38	.66
Work in Process Turnover . . . . .	84.62	53.85	.74
Finished Goods Turnover . . . . .	92.31	68.46	.55
Number of Days Sales in Finished Goods Inventory . . . . .	84.62	57.69	.68
Purchases / Accounts Payable . . . . .	23.08	6.15	2.70
Number of Days Purchases in Accounts Payables . . . . .	23.08	2.31	1.90
Transportation In / Physical Purchases Volume . . . . .	38.46	20.00	1.69
Expense Accounts / Related Accounts . . . . .	61.54	56.92	.86
Prepaid Expense Accounts / Related Accounts . . . . .	61.54	41.15	1.06
Accumulated Depreciation / Related Asset Account . . . . .	61.54	48.85	.95
Payroll Tax Expenses / Wages and Salaries Expense . . . . .	61.54	42.31	.93
Retained Earnings / Net Income after Tax plus Dividend . . . . .	30.77	22.31	1.83
Bad Debts Expense / Net Sales . . . . .	46.15	28.46	1.46
Direct Labor / Work in Process . . . . .	69.23	38.08	.99
Raw Materials / Work in Process . . . . .	69.23	43.46	.88
Factory Overhead / Work in Process . . . . .	69.23	38.08	.99

TABLE 7 - CONTINUED

Financial Relationship	Percent of Participants Who Use this Financial Relationship	% of Audits in Which Employed	Relative Variation in Responses
Product Warranty Expense / Net Sales . . . . .	46.15	33.85	1.28
Sales Expense / Gross Sales . . . . .	38.46	33.08	1.39
Bonuses / Pre-tax Profit . . . . .	30.77	22.69	1.86
Current Ratio . . . . .	92.31	81.92	.40
Quick Ratio . . . . .	61.54	38.46	1.16
Inventory / Current Assets . . . . .	38.46	17.31	2.13
Income from Operations / Tangible Assets . . . . .	38.46	19.23	1.52
Income from Operations / Net Sales . . . . .	84.62	72.69	.52
Debt to Equity . . . . .	53.85	44.62	1.06
Profit to Equity . . . . .	53.85	34.23	1.22
Net Sales . . . . .	100.00	97.69	.06
Cost of Sales . . . . .	92.31	91.54	.30
Gross Profit . . . . .	100.00	92.31	.18
Direct Materials . . . . .	92.31	71.54	.54
Direct Labor . . . . .	100.00	76.54	.41
Factory Overhead . . . . .	100.00	79.62	.40
Customer Service and Installation Repairs and Maintenance . . . . .	38.46	11.15	1.68
Bad Debt Expense . . . . .	100.00	62.69	.58
Expense Accounts . . . . .	92.31	86.92	.34
Prepaid Expense Accounts . . . . .	92.31	84.62	.37
Selling Expenses . . . . .	53.85	32.31	1.19
Administrative Expenses . . . . .	38.46	25.77	1.57
Research and Development Expenses . . . . .	46.15	33.46	1.33
Engineering Expenses . . . . .	46.15	36.54	1.21
Receivables . . . . .	30.77	21.15	1.66
Allowance for Bad Debts . . . . .	92.31	92.31	.30
Inventory Accounts . . . . .	92.31	92.31	.30
Marketable Securities . . . . .	92.31	91.54	.30
Property, Plant and Equipment . . . . .	46.15	39.23	1.19
Intangible Assets . . . . .	53.85	41.15	1.19
Trade Accounts Payable . . . . .	46.15	39.23	1.28
Accrued Liabilities . . . . .	76.92	52.31	.81
Estimated Liability for Product Warranty Expense . . . . .	76.92	60.00	.71
Reserve for Obsolescence . . . . .	76.92	65.00	.69
Working Capital . . . . .	53.85	48.46	1.04
	53.85	40.38	1.12

The computed values of W for the financial ratios and individual accounts are 0.2797 and 0.2824 respectively. If random selection and probability sampling had been applied, a hypothesis test could be formed to evaluate a null hypothesis of no association among the individuals' judgements. Such a hypothesis would be rejected at the 0.005 level of significance in both situations. Thus, the coefficients of concordance can be interpreted to imply that some degree of agreement does exist among the participants.

However, the relatively low values of the test statistic also indicate that substantial variation exists among the auditors in their preference for specific financial relationships. This variation was expected, and can be attributed to differences in individual auditor preferences, varying attitudes toward the reliability of analytical review procedures, differences in the analytical abilities of the individual auditors, and other cognitive factors.

The second column in Table 7 presents the averaged responses for the percentage of audits in which each financial relationship is used. The coefficient of variation is presented in the third column to provide an indication of the relative variation in the individual responses for each financial relationship. It cannot be used to assess the reliability of the estimates.

Review of Table 7 indicates a large variation in many of the responses. Additionally, the amount of variation appears independent of the size of the assessments. A nonstatistical analysis was applied to the individual estimates for each financial relationship to determine if firm or location effects were present. This was accomplished by reviewing the frequency distributions of the individual responses, coded first by firm and then coded by

location. The analysis concentrated on assessing whether a single firm or single location tended to produce consistently high or consistently low responses. No systematic patterns were identified which could be interpreted as firm or location effects. Thus, it appears that the individual auditors have different preferences concerning the form and extent with which some analytical review procedures are applied.

The results of the initial assessments were used as feedback to the participants for their second assessments. To provide better comprehension of these results, they were categorized according to the percentage of audits in which they are applied. Separate categorizations were developed for the financial ratios and the individual accounts. In both cases, the averaged responses were first ranked and then divided into five equal-sized groups. The intervals for each group were then adjusted to provide maximum separation between groups. Thus, the intervals do not represent constant magnitudes. Each group represents a cluster of responses corresponding to the frequency of use.

For the financial ratios, these group intervals are: (a) less than 20 percent, (b) 20 to 35 percent, (c) 35 to 50 percent, (d) 50 to 65 percent, and (e) 65 to 100 percent. The ensuing categorizations are depicted in section I, part A of Appendix D, Follow-up Questionnaire.

For the individual accounts, the group intervals are: (a) less than 35 percent, (b) 35 to 55 percent, (c) 55 to 75 percent, (d) 75 to 90 percent, and (e) 90 to 100 percent. Note that the individual accounts are, on average, applied more frequently than financial ratios. The ensuing categorizations are depicted in section I, part B of Appendix D, Follow-up Questionnaire.

Each participant was asked whether the categorizations of

financial relationships seemed reasonable, based on their general, rather than specific, knowledge of auditing within the manufacturing industry. In those situations where the categorizations did not seem reasonable, the participants were asked to indicate the more appropriate usage category. (See section 1, Appendix D, Follow-up Questionnaire.)

Follow-up estimates. A second assessment of the frequency of use should have less variation due to anchoring on the feedback information. However, the total amount of variation is expected to remain high. The value of the second assessment is that it strengthens the validity of the initial assessments.

Figures 3 and 4 depict the participants' consensus preferences for the financial ratios and individual accounts typically analyzed during an audit of a medium-sized manufacturing firm. Figure 3 shows the categorizations of the percentage of audits in which the financial ratios are analyzed and the results used in forming the audit opinion. The categorizations are based on the averaged follow-up estimates of the participants. The coefficients of variation (CV) are substantially lower than those reported in Table 7. This indicates that EFE method did reduce the total variation in the responses assessed from the participants.

Figure 4 shows categorizations of the percentage of audits in which the individual accounts are analyzed and the results used in forming the audit opinion. The coefficients of variation (CV) are substantially lower than those presented in Table 7.

The results indicate that some variations in the responses still exist. As noted earlier, the major cause of these variations is attributed to differences in individual preferences. Yet there is also strong agreement for some ratios. All the participants indicate that gross margin percentage, allowance for bad debts to

Sales Taxes / Gross Sales CV = .48	Net Sales / Total Assets CV = .41	Sales Discounts / Gross Sales CV = .32	Sales Commissions / Net Sales CV = .29	Gross Margin Percentage CV = .00
Change in cash / receivables CV = .00	Net Sales / Physical Production Volume CV = .37	Sales Returns and Allowances / Gross Sales CV = .26	Number of days sales in accounts receivable CV = .10	Receivables Turnover CV = .13
Purchases / Accounts Payable CV = .66	Prepaid Expense Accounts / Related Accounts CV = .36	Accumulated Depreciation / Related Asset CV = .38	Direct Labor / Cost of Sales CV = .12	Allowance for Bad Debts / Receivables CV = .00
Number of Days Purchases in Accounts Payables CV = .48	Retained Earnings / Net Income after Tax plus Dividends CV = .26	Payroll Tax Expenses / Wages and Salaries CV = .33	Factory Overhead / Cost of Sales CV = .25	Direct Materials / Cost of Sales CV = .24
Transportation in / Physical Purchases Volume CV = .00	Product Warranty Expense / Net Sales CV = .46	Bad Debts Expense / Net Sales CV = .38	Raw Materials / Work in Process CV = .31	Finished Goods Turnover CV = .17
Inventory / Current Assets CV = .81	Bonuses / Pre-tax Profit CV = .46	Direct Labor / Work in Process CV = .31	Raw Materials Turnover CV = .30	Current Ratio CV = .00
Income from Operations / Tangible Assets CV = .40	Profit to Equity CV = .45	Debt to Equity CV = .33	Work in Process Turnover CV = .31	Income from Operations / Net Sales CV = .06
Less than 20%	20% - 35%	35% - 50%	50% - 65%	Greater than 65%
A	B	C	D	E

Fig. 3. The percentage of audits in which the financial ratios are analyzed and the results are used in forming the audit opinion.



accounts receivable, current ratio, and income from operations to net sales are significant ratios that are analyzed on most manufacturing audits. Likewise, there is strong agreement that an analysis of the change in cash to the change in receivables, or freight in to physical purchases volume, does not produce meaningful results in most audits of medium-sized manufacturing firms. Thus, there appears to be a consensus concerning which financial relationships should definitely be analyzed and which relationships should not be analyzed. There are also a large number of relationships that may be significant depending on the specific auditing environment.

An issue which must be addressed is whether these results are generalizable outside of the medium-sized manufacturing environment. Gibson conducted an empirical study of financial executives' preferences of financial ratios. The controllers of Fortune 500 companies rated the significance of 23 specific financial ratios.<sup>10</sup> Of these 23 ratios, eight were also included in this study. The common ratios and their respective rankings are presented in Table 8.

In Table 8, the "Auditor Preference" column presents the categorizations of the common ratios from Figure 3. Hence, category E indicates a higher preference for the ratio than category D. The column "Fin. Exec. Preference" presents the preference ranking of the ratio based on the results of Gibson's study. A value of 5/23 indicates that the ratio was ranked fifth in preference out of the 23 ratios.

A review of Table 8 suggests that the financial ratios

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<sup>10</sup>Charles H. Gibson, "How Industry Perceives Financial Ratios," Management Accounting, April 1982, pp. 13-19.

TABLE 8  
 RATIOS COMMON TO AUDITORS AND  
 FINANCIAL EXECUTIVES

Financial Ratios	Auditor Preference	Fin. Exec. Preference
Debt to Equity . . . . .	C	5 / 23
Gross Margin Percentage .	E	7 / 23
Working Capital . . . . .	C	9 / 23
Inventory Turnover . . . .	E	10 / 23
Number of Days Sales in Accounts Receivable. . .	D	12 / 23
Current Ratio . . . . .	E	13 / 23
Quick Ratio . . . . .	C	14 / 23
Accounts Receivable Turnover . . . . .	E	21 / 23

significant to a financial executive are not necessarily significant to an auditor, and vice versa. None of the four financial ratios evaluated as most significant by the financial executives<sup>11</sup> are included in results showing the auditors' preferences. Gibson suggests that his results were relatively consistent across the various industries. So these results should also apply to financial executives within the medium-sized manufacturing industry.

Are the financial executives and auditors analysis objectives substantially different to warrant these perceived differences in the significance of ratios? Both are concerned with the liquidity and profit generating ability of the company. In fact, 20 of the 23 ratios rated by the financial executives are primarily oriented toward measuring liquidity or profit.

Part of the discrepancy can be explained by the differing objectives of the two studies. The auditor may use these financial ratios to understand the nature of the client's business or as evidence in evaluating the fairness<sup>r</sup> of the financial statements. This study is oriented toward analyzing the use of the ratios as audit evidence. The financial executive uses the financial ratios to evaluate the solvency and profitability of an enterprise. This is similar to the auditor's objective of understanding the nature of the client's business, and was the orientation of Gibson's study.

This limited comparison does not produce sufficient evidence to draw any conclusions concerning the generalizability of the results. The comparison does emphasize a need to evaluate the

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<sup>11</sup>These ratios are earnings per share, return on investment, return on assets, and return on equity. Ibid., p. 15.

theoretical justifications and underlying objectives for applying the analytical procedures. Additional research is needed to determine if alternative objectives for applying the financial relationships changes the auditor's preference toward the use of alternative financial relationships. Research is also needed which investigates auditor preference for financial relationships in other industries.

#### Analytical techniques

There are two components which define the analytical technique applied, the type of analysis and the basis for comparison. The responses assessed from practicing auditors concerning these two components are summarized in Table 9. For each financial relationship, Table 9 shows the percentage of auditors who use it. Of those auditors who do use the financial relationship, Table 9 presents the percentage of auditors who analyze it as a reasonableness test, time trend, or a percentage of gross sales, and the percentage of auditors who compare the results of applying the technique to the financial relationship to industry averages, time trend data, or budget estimates.

Type of Analysis. The data presented in Table 9 under "Type of Analysis" represents how the financial relationship is analyzed by those auditors who use it. For example, "net sales / total assets" is used by six of the thirteen participants. Three of the six apply reasonableness tests and five of the six apply time trend techniques to this financial relationship. Hence, some of the participants apply both reasonableness tests and time trend techniques.

A review of Table 9 suggests that both reasonable tests and time trend techniques are widely used. This indicates a

TABLE 9  
ANALYSIS TECHNIQUE AND COMPARISON CRITERIA FOR  
FINANCIAL RELATIONSHIPS APPLIED DURING AN AUDIT

	Percent of Participants Who Use This Relationship	Type of Analysis			Other	Basis for Comparison		
		Reason-ability	Time trend	% of Gross Sales		Industry Averages	Previous Years Data	Budget Estimates
Gross Margin Percentage	100.00	76.92	92.31	.00	.00	92.31	46.15	.00
Net Sales / Total Assets	46.15	50.00	83.33	.00	.00	100.00	33.33	.00
Net Sales / Physical Production Volume	46.15	50.00	83.33	.00	.00	100.00	33.33	.00
Sales Discounts / Gross Sales	61.54	87.50	82.50	.00	12.50	100.00	12.50	.00
Sales Returns and Allowances / Gross Sales	61.54	62.50	75.00	.00	.00	100.00	12.50	.00
Sales Commissions / Net Sales	76.92	80.00	60.00	.00	20.00	90.00	10.00	.00
Sales Taxes / Gross Sales	30.77	100.00	25.00	.00	25.00	100.00	100.00	.00
Receivables Turnover	100.00	76.92	84.62	.00	.00	100.00	15.38	.00
Number of days sales in accounts receivable	92.31	59.33	83.33	.00	.00	100.00	.00	.00
Change in cash / Change in receivables	30.77	100.00	25.00	.00	.00	100.00	25.00	.00
Allowance for Bad debts / Receivables	92.31	83.33	75.00	.00	8.33	100.00	8.33	.00
Direct Material / Cost of Sales	84.22	30.91	72.73	.00	9.09	100.00	9.09	.00
Direct Labor / Cost of Sales	92.31	91.67	75.00	.00	8.33	100.00	16.67	.00
Factory Overhead / Cost of Sales	92.31	91.67	75.00	.00	8.33	100.00	16.67	.00
Raw Materials Turnover	92.31	100.00	66.67	.00	.00	100.00	16.67	.00
Work in Process Turnover	84.62	81.82	63.64	.00	.00	100.00	.00	.00
Finished Goods Turnover	92.31	91.67	58.33	.00	.00	100.00	.00	.00
Number of Days Sales in Finished Goods Inventory	84.62	72.73	72.73	.00	.00	100.00	.00	.00
Purchases / Accounts Payable	23.08	100.00	66.67	.00	.00	100.00	.00	.00
Number of Days Purchases in Accounts Payable	23.08	66.67	66.67	.00	.00	100.00	.00	.00
Transportation in / Physical Purchases Volume	38.46	80.00	40.00	.00	.00	100.00	.00	.00
Expense Accounts / Related Accounts	61.54	87.50	50.00	.00	.00	100.00	.00	.00
Prepaid Expense Accounts / Related Accounts	61.54	100.00	31.50	.00	.00	100.00	.00	.00
Accumulated Depreciation / Related Asset Account	61.54	87.50	75.00	.00	.00	100.00	.00	.00
Payroll Tax Expenses / Wages and Salaries Expense	61.54	75.00	62.50	.00	12.50	100.00	.00	.00
Retained Earnings / Net Income after Tax plus Dividend	30.77	25.00	100.00	.00	.00	100.00	50.00	.00
Bad Debts Expense / Net Sales	46.15	50.00	66.67	.00	.00	100.00	16.67	.00
Direct Labor / Work in Process	69.23	66.67	88.89	.00	.00	100.00	.00	.00
Raw Materials / Work in Process	69.23	66.67	88.89	.00	.00	100.00	.00	.00
Factory Overhead / Work in Process	69.23	66.67	88.89	.00	.00	100.00	.00	.00
Product Warranty Expense / Net Sales	46.15	66.67	83.33	.00	.00	100.00	16.67	.00
Sales Expense / Gross Sales	38.46	100.00	80.00	.00	.00	100.00	.00	.00
Bonus / Pre-tax Profit	30.77	75.00	50.00	.00	.00	100.00	.00	.00

TABLE 9 - Continued.

	Percent of Participants Who Use This Relationship	Type of Analysis			Basis for Comparison		
		Reason-ability	Time trend	% of Gross Sales	Industry Averages	Previous Years Data	Predict Estimates
Current Ratio	92.31	66.67	75.00	.00	41.67	100.00	.00
Quick Ratio	61.54	50.00	87.50	.00	25.00	87.50	.00
Inventory / Current Assets	38.46	40.00	60.00	.00	20.00	100.00	.00
Income from Operations / Tangible Assets	38.46	40.00	80.00	.00	60.00	100.00	.00
Income from Operations / Net Sales	84.62	54.55	100.00	.00	36.36	100.00	.00
Debt to Equity	51.85	27.14	71.43	.00	14.29	100.00	.00
Profit to Equity	23.85	27.14	71.43	.00	14.29	100.00	.00
Net Sales	100.00	61.24	84.62	46.15	30.77	92.31	92.31
Cost of Sales	92.31	66.67	66.67	91.67	50.00	100.00	91.67
Gross Profit	100.00	76.92	76.92	92.31	53.85	100.00	92.31
Direct Materials	92.31	83.33	75.00	41.67	16.67	91.67	50.00
Direct Labor	100.00	84.62	69.23	38.46	15.38	100.00	46.15
Factory Overhead	100.00	84.62	69.23	38.46	15.38	100.00	46.15
Customer Service and Installation	38.46	60.00	60.00	40.00	15.38	100.00	61.54
Repairs and Maintenance	100.00	92.31	30.77	7.69	.00	100.00	61.54
Rud Debt Expenses	92.31	66.67	75.00	41.67	25.00	100.00	50.00
Expense Accounts	62.31	91.67	58.33	41.67	16.67	100.00	75.00
Prepaid Expense Accounts	51.85	85.71	57.14	14.29	16.67	85.71	42.86
Selling Expenses	58.46	80.00	60.00	40.00	.00	100.00	60.00
Administrative Expenses	46.15	83.33	66.67	50.00	.00	100.00	50.00
Research and Development Expenses	46.15	83.33	66.67	50.00	.00	100.00	50.00
Engineering Expenses	30.77	50.00	50.00	23.33	.00	100.00	50.00
Receivables	92.31	75.00	83.33	50.00	8.33	100.00	50.00
Allowance for Bad Debts	92.31	83.33	91.67	58.33	8.33	100.00	25.00
Inventory Accounts	92.31	75.00	83.33	41.67	25.00	100.00	25.00
Marketable Securities	46.15	100.00	66.67	41.67	25.00	100.00	33.33
Property Plant and Equipment	53.85	85.71	71.43	.00	14.29	100.00	14.29
Intangible Assets	46.15	83.33	83.33	.00	14.29	100.00	14.29
Trade Accounts Payable	76.92	100.00	50.00	.00	10.00	100.00	16.67
Accrued Liability	76.92	100.00	60.00	.00	10.00	100.00	10.00
Estimated Liability for Product Warranty Expense	76.92	50.00	80.00	.00	20.00	100.00	50.00
Reserve for Obsolescence	23.85	85.71	85.71	.00	14.29	100.00	28.57
Working Capital	53.85	85.71	85.71	.00	14.29	100.00	14.29

substantially higher use of reasonableness tests by audit partners and managers than by audit supervisors and seniors.<sup>12</sup> Other types of analysis identified by the participants included:

a. Forming expectations through the use of predictive methods using outside-company data.

b. Forming expectations based on changes in tax laws.

c. Forming expectations based on the phasing of sales.<sup>13</sup>

d. Forming expectations for expense accounts based on the composition of the related balance sheet accounts.

Income statement accounts can be analyzed vertically as a percentage of gross sales. Participants indicate that this is usually accomplished for both cost of sales and gross profit. However, vertical analysis was not widely applied to other income statement accounts. This raises the question as to why vertical analysis is not more widely used. In the follow-up questionnaire, the participants suggest that vertical analysis is not used for the following reasons:

a. Some accounts, such as repairs and maintenance expenses, are not correlated to sales. Rather, they have an historical exposure level similar to the expensing of capitalized items. Hence, there is not a theoretical justification for using gross sales as a deflator for some accounts.

b. Manufacturing firms, especially in highly technical fields, show widely variable ratios by product. Frequent

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<sup>12</sup>Blocher, Esposito and Willingham, p. 11, found a low use of reasonableness tests by the audit supervisors and seniors participating in their study.

<sup>13</sup>Forming an expectation based on the phasing of sales refers to analyzing the seasonal fluctuations of each product line.

variations in unit sales prices and changing product technologies produce variations in expenses that are not related to sales. Again, there is not a theoretical justification for a gross sales deflator.

c. Some auditors rely on detailed substantive testing and other types of analytical review for the operational accounts. Thus, additional benefits are not derived for the cost of the vertical analysis.

Basis for comparison. As expected, a high use of time trend techniques results in a high usage of previous years data to form the comparison criterion. However, industry averages and budget estimates show relatively low use as a comparison basis. (With the exception of budget estimates for sales, cost of sales, and gross profit.) In a study of forty-four small manufacturing firms, Kinney [1981] found that the use of industry ratios as a comparison basis for accounts receivable to sales, inventory to cost of sales, and cost of sales to sales reduced the number of type II errors while increasing the number of type I errors.<sup>14</sup> These results suggest that it may be beneficial to use industry averages as a comparison basis.

In the follow-up questionnaire, participants were asked their opinions as to why industry averages and budget estimates are not more widely used as a basis for comparing the expected audit values. The following reasons were cited with respect to industry averages:

a. Many industry groupings are too broad to be of benefit. Within a grouping, differences in the expected audit

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<sup>14</sup>Kinney, "Paired Balance Methods," pp. 16-17.

values may be due to slightly different products, geographical areas, different manufacturing processes, etc. Each manufacturing firm tends to be unique in some aspect. Hence, the heterogeneity in the manufacturing industry makes comparisons with industry averages meaningless in many situations.

b. Industry averages are not always readily available. When such averages can be obtained, there is a substantial time delay between the effective date of the ratios and the release date. Thus, industry averages are not usually available prior to completion of the audit.

The following explanations were offered as to why operational accounts were not compared with budget estimates:

a. Budget comparisons are not valid in some manufacturing firms due to the use of short operating cycles.

b. Auditors may not view the client's operational budget as being useful information concerning the fairness of the financial statements.

c. Budgets are oriented only towards the income statement accounts. Some form of direct tests of transactions and balances must also be applied to evaluate the balance sheet accounts. Hence, many auditors tend to view direct tests of transactions and balances as being more cost effective than budget comparisons.

d. Clients may not prepare reliable budgets.

In general, reasonableness tests and time trend techniques are applied by the participants, and previous years audited data are used to form the comparison criteria. The comments received from the participants indicate that they are concerned with the theoretical justification of using the techniques, and the cost effectiveness of analytical procedures as compared to other

auditing procedures. If valid industry averages and budget estimates were readily available, many participants indicated that they would use them as a comparison basis.

#### Assessment of decision rules

In the initial interview, each participant was asked to provide some of the rules-of-thumb applied to analytical tests to identify significant fluctuations. The responses were categorized as to whether they applied to income statement or balance sheet accounts. The categorized responses are presented in section I, part C of Appendix D, Follow-up Questionnaire.

A common approach in the Delphi method to derive consensus from open-ended questions is to have the participants rank the summarized initial responses according to individual preferences. The initial responses are then rank ordered by the averaged preference rating, providing an indication of their relative importance.<sup>15</sup> A similar approach is incorporated in the follow-up questionnaire.

Using the results of the follow-up questionnaire, weights were assigned to the decision rules in accordance with the relative rankings of each participant. The weights were then summarized to provide an indication of the consensus preference among the participants. The decision rules and respective weighted scores are listed in Table 10.

A review of Table 10 suggests a preference for those decision rules which incorporate both a materiality threshold as well as a precision interval. Five of the nine income statement decision

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<sup>15</sup>Thomas E. Gibbs and Roger G. Schroeder, "Evaluating the Competence of Internal Audit Departments," (New York: PMM & Co., 1980), pp. 14-26.

TABLE 10

## DECISION RULES

Rule Applied to Income Statement Accounts	Weight
Investigate if the balance of an income statement account exceeds 1% of pre-tax income and changes 10% from the previous year . . . . .	20
Investigate if the change in the account balance is more than 10% of the change in the previous years account balance . . . . .	11
Investigate if the balance exceeds 3% of sales and changes 10% from the previous year . . . . .	11
Investigate if the change in the account varies more than 10% from the budget estimates . . . . .	10
Investigate if an account, expressed as a percentage of gross sales, varies 10% from the previous year . . . . .	8
Investigate if the balance varies 5% from the previous year and the monetary value of the variation exceeds 5% of the functional category . . . . .	7
Investigate if the components in cost of sales vary more than 10% from the variation in net sales . . . . .	6
Investigate if the balance changes 5% from the budgeted amount and the monetary value of the variation exceeds 5% of the functional category . . . . .	4
Rule Applied to Balance Sheet Accounts	Weight
Investigate if the balance exceeds 5% of total assets and changes 10% from the previous year . . . . .	25
Investigate if the balance exceeds 7% of total assets and changes 10% from the previous year . . . . .	20
Investigate if the change in the account balance is more than 10% of the change in the previous years account balance . . . . .	13
Investigate if the change in the account varies more than 10% from the budget . . . . .	7
Investigate if the balance varies 5% from the previous year and the monetary value of the variation exceeds 5% of the functional category . . . . .	6
Investigate if the variation differs from the rate of inflation . . . . .	6
Investigate if the balance changes 5% from the budgeted amount and the monetary value of the variation exceeds 5% of the functional category . . . . .	1

rules and four of the seven balance sheet decision rules include both a precision interval (for example, plus or minus ten percent) and a materiality threshold (for example, exceeding ten percent of net sales). This seems to acknowledge that fluctuations comprise normal business variations and potential monetary errors.

Distinguishing between these two elements is a time-consuming and costly task. Auditors tend to concentrate their efforts on investigating fluctuations which could have a material impact on the financial statements.

#### Analytical procedures in the simulation model

The analytical procedures are comprised of a financial relationship, an analytical review technique and an associated decision rule. The integration of the survey results into the simulation model will be discussed in two sections: (a) financial relationships and (b) the combination of analytical technique and decision rule.

Financial relationships. The extent of the simulation process necessitated a reduction in the total number of financial relationships to be evaluated. The ordinal rankings developed in Figures 3 and 4 are used to select the financial ratios and individual accounts that are commonly analyzed during an audit of a medium-sized manufacturing firm. Those financial relationships which were assessed as being analyzed in more than thirty-five percent of the audits, on average, were designated for inclusion in the simulation process. This includes financial ratios listed in categories (C) to (E) in Figure 3 and individual accounts listed in categories (B) to (E) in Figure 4. Of these designated financial relationships, the following were not included in the simulation

process:

- a. Sales Commissions / Net Sales. Neither firm provided a separate account for sales commissions. Thus, sales commissions could not be separated from sales salaries.
- b. Number of days Sales in Accounts Receivable. This ratio is derived from receivables turnover. Thus, the results of analyzing receivables turnover should also apply to the number of days sales in accounts receivable. Also, the criterion used within the simulation model is expressed in terms of dollars, and cannot be easily converted into days.
- c. Raw Materials Turnover. Neither firm accounted for raw materials inventory.
- d. Work-In-Process Turnover. Neither firm accounted for work-in-process inventory. Within firm B, the time required to produce the finished goods from the raw materials was usually one day. Hence, there was no accumulation of a work-in-process inventory. Firm A did not maintain a work-in-process inventory account.
- e. Number of Days Sales in Finished Goods Inventory. The ratio is proportional to finished goods turnover. Thus, the reasons cited in (b) above also apply.
- f. Estimated Liability for Product Warranty Expenses. Neither firm provided warranties on their products.
- g. Reserve for Obsolescence. Although one firm did expense obsolete inventory items, they did not set up a reserve account. The other firm did not have an inventory obsolescence problem.

Analytical technique and decision rule. With respect to the type of analysis, the evaluations within this study are limited to traditional and simple structural analytical techniques. Ratio analysis and simple linear regression are applied to the financial ratios. The individual financial accounts are analyzed with time trend techniques, either evaluating the differences between two points in time or applying a linear model to a thirty-six month base period to predict the account balances.

With respect to the basis for comparison, the opinions elicited from practicing auditors indicate an apparent emphasis on decision rules which incorporate a materiality threshold. Hence, there are two comparison criteria within the study: (a) a percentage difference over time and (b) an account materiality threshold.

Four analytical technique/decision rule combinations will be applied to each of the financial ratios. The first two combinations apply a benchmark decision rule which incorporates a materiality threshold to evaluate the differences between the ratio calculated at two different points in time. The benchmark methods are similar to the gross profit method of estimating inventories.

The numerator benchmark determines what the value in the numerator account would have been within the current audit period if the value of the ratio did not change from the previous audit period. The balance in the denominator account for the current audit period is used to estimate the value for the numerator account. The estimated numerator is compared to the actual numerator value in the current audit period. An investigation is signalled if the difference equals or exceeds the monthly materiality threshold for the numerator account. The numerator benchmark can be applied on a monthly basis, as an interim test to

cumulative balances in September, or as an end-of-period test to cumulative balances in December.

Likewise, the denominator benchmark estimates the value for the denominator account from the current audit period value in the numerator account, assuming that the value of the ratio remains constant. An investigation is signalled when the differences between the estimated and actual values equal or exceed the monthly materiality threshold for the denominator account. The denominator benchmark can be applied as a monthly or point-in-time cutoff test.

As an example, assume that the ratio of interest is  $A(m)/B(m)$ , where  $m$  represents the month evaluated in the current and past audit period. Let  $A'(m)/B'(m)$  represent the ratio based on the past audit period,  $M(a)$  represent the materiality threshold for the numerator account,  $M(b)$  represent the materiality threshold for the denominator account, and  $n$  represent the number of months in which the total monetary error is seeded. The benchmark decision rules signal investigations if:

$$\begin{aligned} | [A'(m)/B'(m) * B(m)] - A(m) | &\geq M(a)/n. \\ | [A(m) / A'(m)/B'(m)] - B(m) | &\geq M(b)/n. \end{aligned}$$

The third combination of analytical technique and decision rule signals investigation if the value of the ratio evaluated at two different points in time changes ten percent or more. Ten percent appears to be a common medium-risk precision interval, and was commonly included in the decision rules assessed from practicing auditors. Within this study, the two points in time represent the same month in the past and current audit period. Hence, the combination can be applied as a monthly or a point-in-time cutoff test. Using the notation presented above, the third combination signals an investigation if:

$$| [A(m)/B(m) / A'(m)/B'(m)] - 1 | \geq .10.$$

The fourth combination of analytical technique and decision rule involves simple linear regression of the numerator account(s) on the denominator account(s). In the event of multiple accounts for either the numerator or denominator, the account balances are aggregated prior to the regression analysis. An upper precision limit is calculated using the approach developed by Deloitte, Haskins and Sells (DHS).<sup>16</sup> The upper precision limit is calculated as the residual for the month  $m$  plus the computed precision interval for the specified reliability level. The decision rule signals investigation if the computed upper precision limit exceeds the monthly account materiality threshold. The technique can only be applied on a monthly basis.

The DHS approach is limited in that it only detects overstatement errors. Within this study, both overstatement and understatement errors are possible. For understatement errors, the lower precision limit is compared to the monthly account materiality threshold to determine whether to investigate. Thus, both the upper and lower precision limits are calculated for each month evaluated within the simulation model.

Note that the upper and lower precision limits are expressed in terms of deviations from the regression line, and not in absolute amounts. Investigations are signalled if either the upper or lower precision limits equal or exceed the account materiality threshold, which is also expressed in terms of deviations from the true audited values.

Four combinations of analytical techniques and decision rules are applied to the individual financial accounts. The first

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<sup>16</sup>See Kinney and Salamon, "Alternative Investigation Rules," pp. 4-7, for a discussion of the approach developed by DHS.

combination applies a benchmark decision rule to the balances within an individual account at two points in time. The benchmark decision rule signals investigation if the difference in the account balances for corresponding months in the past and current audit periods equals or exceeds the monthly account materiality threshold. Hence, this combination can be applied as a monthly or point-in-time cutoff test. This decision rule is designated "material change."

The second combination incorporates the decision rule identified as most preferred by the practicing auditors. For income statement accounts, the decision rule signals investigation if the account balance equals or exceeds five percent of the pre-tax income and changes ten percent or more from the previous year. For balance sheet accounts, the decision rule signals investigation if the account balance equals or exceeds five percent of total assets and changes ten percent or more from the previous year. Both combinations can be applied as a monthly or point-in-time cutoff test.

The second most preferred decision rule for balance sheet accounts differs only in the materiality basis, requiring the account balance to equal or exceed seven percent of total assets as opposed to five percent of total assets. Thus, the first choice should be more sensitive than the second choice, resulting in a higher type I error rate but a lower type II error rate. Only the first choice is included in this study, designated as "yearly change."

The third combination of time trend and decision rule considers monthly changes within the current audit period, and is designated as "monthly change." The decision rule signals investigation if two sequential monthly account balances of the

income statement account, expressed as a percentage of gross sales, differ by ten percent or more. Because the technique is applied to the monthly balances in the accounts, it cannot be used as a point-in-time cutoff test.

As noted earlier, ten percent appears to be a commonly used medium-risk precision interval. The gross sales deflator was chosen since it is commonly suggested within accounting textbooks as the deflator for vertical analysis of an income statement. Gross sales may not be the best deflator for those accounts which are not highly correlated with gross sales.

For balance sheet accounts, total assets were used as the deflator. The purpose of the total asset deflator was to allow the use of the ten percent precision interval. Thus, the balance sheet decision rule signals investigation if the monthly account balance, expressed as a percentage of total assets, changes ten percent or more from the previous month's balance.

The fourth combination of time trend and decision rule for the individual accounts is a simple linear model of the time series data. This time series model is identical to the regression model applied to financial ratios. The monthly account balances represent the dependent variable, while the numeric value corresponding to the month represents the independent variable. Hence, the independent variable ranges from one to thirty six, with the first month in the thirty-six month base period being valued at one, and the last month being valued at thirty-six. The DHS approach is again applied to develop both upper and lower precision limits, which are compared to the monthly materiality thresholds to determine if investigations are needed. The fourth decision rule is designated "time series."

### Summary

This section analyzed the survey results concerning analytical review procedures. Auditor assessments were obtained which indicate the frequency with which alternative financial relationships are applied during audits of medium-sized manufacturing firms. Thirty-two relationships which are applied, on average, in more than thirty-five percent of the audits were included in the simulation model.

Auditor assessments indicate that ratio and time trend techniques are widely used in practice. Although none of the participants applied regression analysis, this technique is widely applied in practice by Deloitte, Haskins and Sells. Two comparison criterion emerged from the analysis of survey results, differences over time and relative value with respect to a materiality threshold. Hence, these three techniques and two criteria were integrated into the simulation model.

Four combinations of decisions rules and analytical techniques are applied in the simulation model. For financial ratios, numerator benchmark (time trend with materiality-based decision rule), denominator benchmark (time trend with materiality-based decision rule), ten percent change (time trend with a traditional decision rule), and regression (structural model with statistical decision rule) procedures are applied. For individual accounts, material change (time trend with a materiality-based decision rule), yearly change (time trend with a traditional decision rule), monthly change (monthly time trend with a traditional decision rule) and time series (structural model with a statistical decision rule) procedures are applied. These combinations were formed from the techniques and decision rules

suggested for use by practicing auditors.

### Characteristics of Monetary Errors

The results of the initial estimates concerning the characteristics of monetary errors are presented in three sections; monetary error rates, largest expected monetary errors and monthly distribution of monetary errors.

#### Monetary error rates

Survey results. Table 11 contains the results of the initial estimates of monetary error rates. Across the top of the table are the likelihoods that an error will occur during an audit and that the error will be material given that it has occurred. For each category, the averaged response and coefficient of variation are presented.

A review of Table 11 indicates large relative variation in the responses. The lowest variation, and therefore the highest degree of agreement, appears in accrual transactions. The participants' responses have the highest variation concerning the likelihood of errors in sales, sales returns, cash receipts, purchase returns and allowances and cash disbursement transactions.

Kendall's coefficient of concordance was applied to the individual responses across the 106 error sources to derive the degree of concordance among the participants. The calculated statistics are: 0.3292 for the likelihood of a monetary error arising from each source during an audit, 0.2245 for the likelihood that a monetary error which does result from a potential source of error is material, and 0.2085 for the likelihood that monetary errors resulting from related sources of errors are material when

TABLE 11  
 LIKELIHOOD AND SIZE OF MONETARY ERRORS -- INITIAL ESTIMATES

Error Source	Likelihood of a Monetary Error from a Single Source		Likelihood of a Material Error From Related Sources		Largest Error as a Percentage of Net Income B.F.		Largest Irregularity (% of Net Inc. B.F.)			
	Average	CV	Average	CV	Average	CV	Average	CV		
Sales Transactions										
Goods shipped but not invoiced.	28.923	1.179	7.923	1.818	19.308	1.124	5.692	1.057	7.846	1.691
Sales recorded but goods not shipped	32.077	.837	17.769	1.369	23.538	.971	13.231	2.038	19.769	1.445
Sales invoiced but not recorded.	16.545	1.786	10.727	2.106	15.091	1.270	10.909	2.723	14.273	2.247
Sales recorded before legal title passes.	25.385	.834	13.923	1.316	23.077	.904	13.385	2.010	16.462	1.643
Invoice recorded incorrectly in journal.	34.308	1.306	2.846	2.428	7.462	1.897	2.462	2.204	8.692	3.172
Wrong prices used on invoice.	31.750	1.091	1.853	1.738	14.417	1.553	3.667	.982	12.167	2.349
Wrong quantity shown on shipping document and sales invoice.	27.000	1.192	1.909	1.744	20.818	1.543	3.091	1.257	4.091	1.857
Wrong quantity shown on invoice; shipping document correct.	18.167	1.481	.503	2.474	9.583	2.196	3.167	1.196	3.833	1.903
Wrong extension of quantity and price on sales invoice.	15.000	.930	2.000	1.748	17.500	1.793	3.900	1.664	13.700	2.288
Wrong period credited for sale.	47.500	.702	11.667	.615	36.917	.702	13.417	1.195	22.417	1.358
Sales classified erroneously as to type.	27.333	.959	1.167	1.708	11.250	2.404	3.250	1.319	3.500	2.519
Unearned interest included as revenue.	15.250	1.605	1.375	2.547	17.375	1.961	2.625	1.303	2.875	1.294
Incorrect recording of sales tax liability.	9.182	.709	6.455	1.986	16.727	1.742	4.455	1.961	4.000	2.222
Sales commission erroneously recorded.	15.000	.537	1.636	1.374	16.818	1.630	4.091	.814	4.364	2.012
Quoted price not used on invoice.	20.417	1.960	1.853	1.753	14.667	1.861	2.250	1.528	1.833	1.738
Duplicate shipments.	11.917	1.990	2.083	1.605	16.417	1.917	1.750	1.690	9.750	2.930
Billing terms incorrect.	27.462	1.089	1.385	2.137	15.769	1.906	6.308	2.560	6.602	2.297
Milling of wrong customer.	13.333	1.025	4.667	2.141	11.667	1.107	7.500	1.298	7.000	1.440

TABLE 11 - Continued.

Error Source	Likelihood of a Monetary Error from a Single Source		Likelihood of a Material Error From a Single Source		Related Sources		Largest Error as a Percentage of Net Income B.T.		Largest Irregularity (% of Net Inc. B.T.)	
	Average	CV	Average	CV	Average	CV	Average	CV	Average	CV
<b>Sales Return Transactions</b>										
Goods returned; no credit given to customer.	26.917	1.072	2.333	1.658	24.583	1.325	2.750	1.326	4.167	1.881
Goods not returned; credit given to customer.	8.111	.707	.333	2.121	15.222	2.134	2.111	1.579	3.667	1.762
Returns classified erroneously as to type of sale.	18.455	1.118	1.000	3.000	18.727	1.847	2.091	1.458	1.636	1.930
Credit given for goods never recorded as a sale.	6.625	.703	1.375	2.547	18.125	1.978	4.625	2.247	19.000	1.951
Goods returned but not reentered into inventory system.	35.167	1.004	6.417	1.315	30.833	1.199	5.667	1.280	1.917	1.549
Wrong quantity/price credited for returned goods.	30.667	1.086	1.833	1.738	12.167	2.337	2.167	1.403	1.833	1.642
Error in extension on credit memorandum.	14.769	1.065	1.615	1.934	11.462	2.387	1.923	1.552	1.769	1.744
Wrong period credited for return.	39.462	.736	4.385	1.364	21.923	1.357	4.536	1.293	4.231	1.627
Wrong items credited for return.	13.167	1.211	1.333	2.313	13.333	2.206	1.917	1.642	9.333	3.075
<b>Sales Allowances Transactions</b>										
Allowance granted but not recorded.	11.000	.589	3.545	1.245	21.818	1.289	3.364	1.099	3.000	1.491
Wrong period credited for allowance.	27.917	.991	4.500	1.280	17.500	1.348	3.750	1.115	5.000	1.697
Sales allowance incorrectly valued.	8.250	.525	3.750	2.337	2.625	1.739	2.500	1.352	4.000	1.827
<b>Cash Receipts Transactions</b>										
Cash not deposited or recorded.	13.778	1.203	1.333	1.591	16.889	1.823	2.232	1.489	14.111	2.306
Cash recorded but not deposited.	20.455	1.333	1.091	1.808	13.455	2.067	10.818	2.749	11.091	2.675
Cash deposited but not recorded.	19.100	1.502	1.600	1.479	13.300	2.183	11.700	2.664	11.400	2.213
Cash amount recorded incorrectly.	23.364	1.539	1.455	1.575	11.000	2.250	2.091	1.426	11.826	2.548
Cash credited to wrong sub-account.	34.833	1.064	.503	2.580	3.917	1.083	1.083	2.654	1.667	2.464
Cash recorded in wrong period.	37.306	.715	10.769	1.311	17.308	1.189	4.923	1.430	10.462	2.632
Improper recording of interest collected on receivables.	16.700	1.417	.200	2.108	2.700	2.330	1.800	1.811	1.100	2.857

TABLE 11 - Continued.

Error Source	Likelihood of a Monetary Error from a Single Source		Likelihood of a Material Error From a Single Source		Related Sources		Largest Error as a Percentage of Net Income B.T.		Largest Irregularity (% of Net Inc. B.T.)	
	Average	CV	Average	CV	Average	CV	Average	CV	Average	CV
<b>Bad Debt Write-off Transactions</b>										
Collectible accounts written-off. . . . .	34.727	1.211	4.182	1.481	5.636	1.128	1.909	1.597	11.364	2.639
Uncollectible accounts not written-off . . . . .	55.833	.569	15.000	1.064	25.833	.849	8.083	1.073	21.083	1.794
Recoveries not recorded . . . . .	7.800	.704	4.100	1.100	11.100	1.650	2.000	1.599	4.500	1.497
<b>Factoring or Assigning Transactions</b>										
Sale or assignment of receivables not recorded. . . . .	9.167	.638	38.333	1.071	20.000	1.498	18.667	2.145	21.500	1.802
Cash proceeds from sale or assignment not deposited. . . . .	7.833	.829	40.000	1.181	30.000	1.160	21.833	1.837	29.833	1.310
<b>Other Transactions</b>										
Failure to provide adequate product warranty liability. . . . .	37.273	.625	29.091	.768	25.455	.758	17.727	1.572	4.182	1.904
<b>Purchases Transactions</b>										
Liability incurred but not recorded. . . . .	73.462	.448	16.308	1.090	23.154	1.044	25.077	1.410	19.462	1.884
Purchases recorded but goods not received. . . . .	24.636	1.161	4.273	1.113	19.182	1.365	14.909	1.979	49.727	3.005
Purchases incorrectly valued. . . . .	30.000	1.041	4.308	1.475	19.231	1.431	6.769	1.337	6.769	1.495
Purchases incorrectly classified. . . . .	30.000	.975	4.545	1.450	13.636	1.941	3.000	1.508	10.182	2.932
Purchases recorded in wrong period. . . . .	57.308	.663	17.769	.988	28.154	.789	18.154	1.452	19.769	1.853
<b>Purchases Returns &amp; Allow Transactions</b>										
Goods returned but no credit received. . . . .	26.250	1.137	2.750	1.405	12.083	1.326	3.167	.921	.667	2.153

TABLE 11 - Continued.

Error Source	Likelihood of a Monetary Error from a Single Source		Likelihood of a Material Error From Related Sources		Largest Error as a Percentage of Net Income B.T.		Largest Error as a Percentage of Net Income B.T.		
	Average	CV	Average	CV	Average	CV	Average	CV	
Purchases Returns & Allow Transactions - Continued									
Credit received but goods not returned.	9.818	1.393	1.808	4.545	1.665	2.364	.951	1.545	2.054
Wrong quantity/price credited for returned goods.	22.727	1.273	2.764	4.182	1.827	1.636	1.168	1.091	1.854
Wrong period credited for return.	26.538	1.207	1.007	10.538	1.157	3.923	.861	2.154	1.787
Receipt of Goods Transactions									
Damaged or missing goods not reported.	44.167	.990	1.148	7.750	1.146	3.500	.822	5.500	2.608
Cash Disbursements Transactions									
Payments recorded but not made.	15.091	1.342	1.087	16.818	1.528	4.000	1.051	13.636	2.318
Payment made but not recorded.	8.667	1.259	1.634	4.444	1.535	2.667	1.272	3.778	1.261
Payment accounts recorded incorrectly.	21.250	1.538	1.291	5.167	1.410	2.667	1.460	3.083	1.427
Payment based on incorrect terms or price.	38.750	1.078	1.463	4.593	1.706	2.917	1.287	3.000	1.435
Payment recorded in wrong period.	32.705	1.019	1.162	11.154	1.322	5.923	1.214	3.615	1.305
Divergence of payments.	10.700	2.528	1.616	22.500	1.433	2.600	1.396	16.100	1.898
Duplicate payments.	34.583	.364	1.832	9.167	1.466	2.250	1.328	8.667	3.319
Payment for cancelled orders.	5.875	.646	1.852	6.875	2.018	2.375	1.475	1.750	1.950
Prepayments Transactions									
Prepayments are incorrectly valued.	12.909	1.656	1.909	6.818	1.282	2.545	1.222	2.909	2.204
Related expenses are not properly classified.	13.923	.957	1.308	5.305	1.338	3.000	2.293	.538	2.693

TABLE 11 - Continued.

Error Source	Likelihood of a Monetary Error from a Single Source		Likelihood of a Material Error From: a Single Source		Related Sources		Largest Error as a Percentage of Net Income B.Y.		Largest Irregularity (% of Net Inc. N.T.)	
	Average	CV	Average	CV	Average	CV	Average	CV	Average	CV
Prepayments Transactions - Continued										
Prepayments are recorded in wrong period . . . . .	15.000	.907	3.273	1.215	7.455	1.302	2.455	1.280	2.000	2.000
Prepaid items not listed as prepaid . . . . .	40.000	.907	1.231	1.760	6.692	1.218	2.615	.848	1.769	1.682
Items listed as prepaid that are not prepaid . . . . .	15.556	.901	2.444	1.433	2.556	1.673	9.333	1.681	2.333	1.530
Accruals Transactions										
Failure to include items that should be accrued . . . . .	69.231	.514	15.769	.562	23.462	.480	25.462	1.232	20.231	1.810
Accrual of items that should not be accrued . . . . .	32.000	.782	11.875	.673	10.625	.956	11.675	1.320	6.375	1.651
Accruals incorrectly valued . . . . .	46.538	.677	8.462	.883	17.077	.525	17.154	1.684	11.385	2.419
Accruals recorded in wrong period . . . . .	43.846	.742	10.923	.990	17.692	.561	20.077	1.582	17.385	2.119
Related expenses not properly classified . . . . .	29.000	1.140	3.200	1.050	8.500	.879	2.900	1.384	1.300	1.983
Payroll Transactions										
Employees paid for work not performed . . . . .	26.375	1.273	1.250	1.852	8.875	1.605	2.000	1.690	1.625	2.105
Employee wages calculated using wrong hourly rate . . . . .	15.154	.861	.538	2.693	4.538	2.084	1.308	2.056	1.462	2.102
Employees not paid for hours worked or production completed . . . . .	29.333	1.216	.167	2.449	7.000	1.443	2.000	1.975	2.000	1.975
Overtime or shift differential hours not recognized . . . . .	16.250	.539	.750	2.337	5.875	1.513	1.625	2.105	2.125	2.457
Employee paid for unauthorized vacation/sick time . . . . .	14.600	.580	1.100	1.890	7.700	1.289	1.800	1.693	1.500	2.043

TABLE 11 - Continued.

Error Source	Likelihood of a Monetary Error from a Single Source		Likelihood of a Material Error From Related Sources		Largest Error as a Percentage of Net Income B.T.					
	Average	CV	Average	CV	Average	CV				
<b>Payroll Transactions - Continued</b>										
Misappropriation of unclaimed wages . . . . .	3.285	.651	.714	2.646	2.429	1.574	.714	2.646	.857	2.175
Mathematical errors in calculation of payroll . . . . .	33.636	1.279	.727	2.138	3.091	1.944	1.273	1.170	1.636	1.918
Erroneous recording/classification of compensation . . . . .	16.083	.839	2.500	1.259	4.500	1.532	3.083	1.248	5.000	2.851
Incorrect handling of end-of-period accruals . . . . .	28.846	.991	5.462	1.361	16.692	.979	7.692	1.225	9.615	2.860
Expense reimbursement inaccurately calculated . . . . .	23.300	1.266	.100	3.162	2.100	2.999	1.100	1.385	1.900	1.691
<b>Allocation of Labor Transactions</b>										
Hourly costs of direct labor incorrectly valued . . . . .	13.000	.751	6.667	1.123	12.167	.858	5.250	1.183	3.333	2.153
Hours required to manufacture unit recorded incorrectly . . . . .	23.833	.935	13.417	1.003	19.250	.544	11.500	1.242	13.000	2.183
Labor performed but not correctly allocated . . . . .	9.700	.718	2.000	1.291	4.500	1.430	2.200	1.450	1.600	2.087
Wages/salaries improperly classified . . . . .	12.769	.717	3.615	1.007	8.077	1.302	2.846	1.062	3.395	1.519
<b>Storage Transactions</b>										
Obsolete items maintained in inventory . . . . .	69.231	.429	9.615	.835	22.077	.947	12.923	1.073	8.385	1.298
Consigned out items are double counted in inventory . . . . .	14.545	.676	18.818	1.579	7.727	1.240	5.727	.765	4.727	1.566
Consigned in items are counted in inventory . . . . .	18.875	.601	13.875	1.361	16.000	1.236	9.000	.988	2.625	.975

TABLE 11 - Continued.

Error Source	Likelihood of a Monetary Error from a Single Source		Likelihood of a Material Error From a Single Source		Largest Error as a Percentage of Net Income B.W.		Largest Irregularity (% of Net Inc. B.T.)			
	Average	CV	Average	CV	Average	CV	Average	CV		
Raw Mat. to WIP Transactions - Continued										
Material requisitions not recorded.	43.846	.915	3.769	1.073	10.923	1.098	6.385	1.246	2.077	1.451
Material requisitions are incorrectly recorded.	41.667	.969	2.333	1.648	8.167	1.420	4.417	1.603	.833	1.760
Material requisitions recorded in wrong period.	46.818	.845	6.000	1.323	12.273	1.214	5.182	1.678	1.364	1.582
Material requisitions incorrectly classified.	35.500	1.174	2.100	1.641	7.000	1.269	3.700	2.066	.800	2.024
WIP to FG Transactions										
Costs of material, labor and overhead incorrectly recorded	21.923	1.072	5.462	.675	17.077	.739	6.538	1.390	5.154	1.808
Cost of material, labor and overhead incorrectly valued	38.462	.982	8.769	1.144	19.462	.831	10.077	1.020	10.923	2.502
Costs of material, labor and overhead incorrectly classified	19.769	1.464	2.538	1.252	4.077	1.094	2.846	1.274	1.154	1.654
Record material, labor and overhead in wrong period.	16.818	.568	5.636	1.321	10.818	1.093	7.000	1.328	1.636	1.479
Incorrect quantity transferred to finished goods.	13.333	.605	3.083	1.039	6.917	1.051	3.500	1.030	2.167	1.444
FG to Inventory Transactions										
Incorrect allocation of costs of storing goods	14.571	.937	2.286	1.688	4.429	.983	3.000	1.041	1.571	1.154
Finished goods not recorded	22.000	1.002	9.375	1.796	6.675	1.225	3.375	1.038	2.000	1.832
Finished goods recorded at incorrect value	22.727	.966	6.182	1.210	10.091	1.027	4.273	1.652	2.455	1.360
Finished goods recorded in wrong period.	13.714	1.014	10.000	1.118	16.429	1.175	2.857	1.269	4.143	1.250

TABLE 11 - Continued.

Error Source	Likelihood of a Monetary Error from a Single Source		Likelihood of a Material Error From a Single Source		Related Sources		Largest Error as a Percentage of Net Income B.V.		Largest Irregularity (% of Net Inc. N.T.)	
	Average	CV	Average	CV	Average	CV	Average	CV	Average	CV
Quantity shipped does not agree with quantity ordered	32.308	.913	2.462	1.237	5.462	1.553	2.462	1.203	2.615	1.460
Goods shipped different from goods ordered	26.923	1.281	1.300	1.663	4.692	1.326	1.385	1.269	1.308	2.260
Goods shipped to fictitious customer	2.333	.897	20.556	1.400	19.556	1.289	3.889	1.188	7.222	1.181
Goods shipped to wrong party	17.545	1.510	.636	2.462	3.636	1.387	1.000	1.549	2.364	1.716
Goods shipped too early or too late	20.000	1.677	15.000	1.277	9.429	1.189	4.714	1.051	2.429	1.556

Shipments Transactions - Continued

aggregated. If random selection and probability sampling had been used, a null hypothesis of no association between the participants' judgements would be rejected at the 0.005 level of significance for all three situations. Even though there is substantial variation in the individual responses, there does exist some degree of agreement among the participants.

Nonstatistical analysis of the individual responses did not reveal any patterns which indicate firm or location effects. It is assumed that each auditors' assessments are based upon a similar background of audits. Each auditor is experienced with the auditing process applied to medium-sized manufacturing firms. The responses were based on an average of sixty audits per participant. Assuming that firm, location and auditor background are not the major causes of variation, the question is raised as to what other underlying factors account for the variation.

This question was investigated by asking each participants' opinion as to why the individual responses were so varied. However, it was not feasible to accomplish this process for all 106 error sources for each of the three questions concerning the likelihood of errors. As a result, three error sources were systematically selected for each assessment question.

The selection process involved grouping the error sources with the highest variations according to the distribution of the individual responses: (a) bimodal distributions with most responses in the low range, (b) bimodal distributions with most responses in the high range, and (c) uniform distributions of responses. One error source was then randomly selected from each distribution category. Each participant was provided feedback information containing his response and all other responses given to a specific question. Based on this information, participants

were asked to explain the variation. The questions addressing the variation in the initial estimates are presented in section II, part B of Appendix D, Follow-up Questionnaire.

The following explanations were offered by the participants regarding the variation in the participants' responses concerning the likelihood that a monetary error would result, regardless of the size of the error:

- a. Audit procedures are applied to test controls. If controls are considered good, then the auditor will assume a low occurrence rate for the errors. Personal experiences of the auditors establish the general opinion concerning the validity of controls for certain error sources. Large likelihood assessments typically assume that controls are always ineffective, and allow errors to enter the accounts. Small likelihood assessments assume that the audit controls will catch all such errors.
- b. Likelihood assessments will vary depending on the volume of transactions within the particular clients which comprise the auditor's experience.
- c. Problems may have occurred in interpreting the questions. The participants' may have assumed that small errors were insignificant, and only based their answers on larger errors.
- d. Likelihoods will vary with the organizational diversity of the clients. High likelihoods are expected when clients allow a large number of individuals to commit the firm to liabilities, approve discounts and returns, etc.
- e. Answers are expected to vary with the periodicity of the clients. Firms preparing monthly financial statements would have a higher occurrence of errors than firms preparing financial statements only on a yearly basis.
- f. Likelihood assessments will vary with different

accounting policies of the participants' clients. Specifically, when are sales, liabilities and accruals recorded and are the books closed on a timely basis, etc.

The following opinions were offered to explain variations in the participants' responses concerning the likelihood that a monetary error which results from a single source of error is material:

a. Likelihood assessments are expected to vary depending on the length of operating cycles of the clients, the method of revenue recognition, and the time of physical inventories.

b. Likelihood assessment will vary depending on the auditor's confidence in audit controls applied to detect and correct the monetary errors. Again, personal experiences with the auditors' clients may result in high likelihood assessments.

c. Periodicity affects the likelihood estimates. Some errors are only significant at the end of an accounting period.

The final assessment question concerns the likelihood that the aggregate monetary error which results from related sources of error is material. In other words, given that a monetary error has occurred, the presence of that monetary error indicates that other monetary errors would also exist in the financial statements that, when aggregated, would have a material impact. As would be expected, the likelihood of material monetary errors from related sources is generally higher than the likelihood of a material monetary error from a single source. Variations in these assessments were explained by the following factors:

a. There may have been interpretation problems with the question. What constitutes a related error source? The higher likelihood assessments may encompass a wider range of related

errors. Additionally, some participants may consider that the related error would have a material effect, while others consider the effects of related errors to be non-material.

b. Some errors may only be significant at the end of an accounting period.

c. There may have been varied personal experience concerning the validity of internal controls.

It was also necessary to corroborate the initial estimates in an effort to reduce the variation. The results presented in Table 11 were used as the basis for the corroboration process. To facilitate analysis, the averaged responses were categorized according to the likelihoods of error from each source. Seven categories were used due to the large number of potential error sources. For each of the three questions (likelihood of a monetary error, likelihood of a material monetary error from a single source, and likelihood of a material monetary error from related sources), the averaged responses were ranked and divided into seven approximately equal-sized groups. As with the analytical review procedures, the intervals of the groups were adjusted such that each group represents a cluster of responses corresponding to the likelihood of occurrence. The resulting intervals for each of the three questions are presented in Table 12.

It was not feasible to corroborate the responses to all three questions for all 106 error sources. Hence, only those error sources with large variations were selected for corroboration. The variation for an error source was considered large if its standard deviation exceeded five times the interval width of its categorization. This arbitrary rule produced 50, 25 and 50 error sources for corroboration for questions one, two and three, respectively.

TABLE 12  
 CATEGORIZATION INTERVALS FOR LIKELIHOOD AND SIZE OF MONETARY ERRORS

Category and Interval	Percentage of Audits in which Errors are Expected		Size Of Monetary Error (Multiples of a Material Amount	
	Likelihood of Error	Likelihood of Material Error from:		
		a Single Source		Related Sources
A (1.0-1.5)	0 - 8%	0 - 1%	0 - 5%	
B (1.5-2.5)	8 - 12	1.00 - 1.75	5 - 8	
C (2.5-3.5)	12 - 15	1.75 - 2.50	8 - 11	
D (3.5-4.5)	15 - 20	2.50 - 4.00	11 - 14	
E (4.5-5.5)	20 - 28	4.00 - 6.00	14 - 17	
F (5.5-6.5)	28 - 36	6.00 - 12.00	17 - 20	
G (6.5-7.0)	36 - 73	12.00 - 40.00	20 - 37	

To make the process more comprehensible, the error sources were further grouped by major transaction cycle; namely, sales and collection, acquisition and payments, payroll and personnel, and inventory and warehousing. Participants were asked to indicate whether they agreed with the likelihood categorizations or to indicate the more appropriate likelihood category. The corroboration process is presented in section 2, part B of Appendix D, Follow-up Questionnaire.

The averaged follow-up estimates are presented in Table 13. Coefficients of variation are presented for those error sources which were included in the follow-up questionnaire. The error sources not included are annotated with "n/i". The coefficients of variation are presented in units of error categories, not in units corresponding to frequency of occurrence. The coefficients of variation only indicate the extent of the relative variation, and cannot be used to assess the reliability of the estimates.

Review of Tables 11 and 13 indicate that the amount of relative variation is less in the follow-up estimates than in the initial estimates. The range of the relative variation in each of the three likelihood assessments for both Tables 11 and 13 are presented in Table 14. This suggests that the EFE method did reduce the relative variation in the assessments by the participants.

Use in simulation model. Table 13 provides the basis for selecting those monetary error sources which have the greatest impact on the financial statements. The monetary error sources were ranked by the joint likelihood that a monetary error results from a potential error source and that the monetary error from the single source of error has a material impact on the financial

TABLE 13  
 LIKELIHOOD AND SIZE OF MONETARY ERROR -- REVISED ESTIMATES  
 Averaged Categorical Responses from Follow-Up Questionnaire (See Table 12 for Categories)

Error Source	Likelihood of a Monetary Error from a Single Source						Likelihood of a Material Error From Related Sources			Largest Error		Largest Irregularity	
	Average	CV	Average		CV	Average	CV	Average	CV	Average	CV	Average	CV
			Average	CV									
Goods shipped but not invoiced.	4.846	.313	4.923	.255	5.154	.261	2.923	.295	3.000	.272			
Sales recorded but goods not shipped	6.077	.046	6.154	.238	6.077	.246	2.846	.132	3.000	.272			
Sales invoiced but not recorded	3.305	.531	5.154	.222	3.769	.116	1.000	n/1	1.000	n/1			
Sales recorded before legal title passed.	5.000	n/1	6.154	.238	6.077	.264	2.769	.366	3.000	.272			
Invoice recorded incorrectly in journal	5.539	.175	4.000	n/1	2.000	n/1	1.000	n/1	1.000	n/1			
Wrong prices used on invoice.	5.462	.206	2.000	n/1	4.846	.077	1.615	.313	1.923	.144			
Wrong quantity shown on shipping document and sales invoice.	4.769	.126	2.000	n/1	5.769	.293	1.000	n/1	1.000	n/1			
Wrong quantity shown on invoice; shipping document correct	4.000	n/1	1.000	n/1	2.923	.219	1.000	n/1	1.000	n/1			
Wrong extension of quantity and price on sales invoice.	2.000	n/1	2.000	n/1	4.846	.277	1.000	n/1	1.000	n/1			
Wrong period credited for sale.	6.538	.172	6.000	n/1	6.154	.264	3.615	.266	3.769	.221			
Sales classified erroneously as to type.	5.000	n/1	2.000	n/1	3.692	.130	1.000	n/1	1.000	n/1			
Unearned interest included as revenue	2.000	n/1	1.000	n/1	5.308	.248	1.000	n/1	1.000	n/1			
Incorrect recording of sales tax liability	1.000	n/1	5.154	.222	4.615	.141	1.000	n/1	1.000	n/1			
Sales commission erroneously recorded.	3.000	n/1	2.000	n/1	4.462	.197	1.769	.248	1.923	.257			
Quoted price not used on invoice.	4.000	n/1	3.000	n/1	4.530	.171	1.000	n/1	1.000	n/1			
Duplicate shipments	2.000	n/1	3.000	n/1	4.231	.219	1.000	n/1	1.000	n/1			
Billing terms incorrect	4.769	.192	2.000	n/1	4.462	.197	1.000	n/1	1.000	n/1			
Billing of wrong customer	1.000	n/1	3.923	.243	2.000	n/1	1.000	n/1	1.000	n/1			

Sales Transactions

TABLE 13 - Continued.

Error Source	Averaged Categorical Responses from Follow-Up Questionnaire (See Table 12 for Categories)						Largest Error	Average	CV	Largest Irregularity
	Likelihood of a Monetary Error from a Single Source		Likelihood of a Material Error From Related Sources		CV	Average				
	Average	CV	Average	CV						
Sales Return Transactions										
Goods returned; no credit given to customer.	4.462	.217	3.000	n/1	5.615	.296	1.000	n/1	1.000	n/1
Goods not returned; credit given to customer.	1.000	n/1	1.000	n/1	4.385	.219	1.000	n/1	1.000	n/1
Returns classified erroneously as to type of sale.	4.000	n/1	1.308	.848	5.077	.260	1.000	n/1	1.000	n/1
Credit given for goods never recorded as a sale.	1.000	n/1	1.000	n/1	5.077	.260	1.000	n/1	1.000	n/1
Goods returned but not reentered into inventory system.	5.692	.132	5.000	n/1	6.077	.264	1.769	.248	1.846	.203
Wrong quantity/price credited for returned goods.	4.923	.268	2.000	n/1	3.846	.098	1.000	n/1	1.000	n/1
Error in extension on credit memorandum.	3.000	n/1	2.000	n/1	3.923	.071	1.000	n/1	1.000	n/1
Wrong period credited for sales return.	6.692	.166	5.000	n/1	5.846	.287	1.923	.333	1.923	.257
Wrong items credited for return.	5.000	n/1	2.000	n/1	5.769	.116	1.000	n/1	1.000	n/1
Sales Allowances Transactions										
Allowance granted but not recorded.	2.000	n/1	4.000	n/1	6.000	.264	1.000	n/1	1.000	n/1
Wrong period credited for allowance.	4.923	.211	5.000	n/1	5.452	.192	1.769	.339	2.000	.204
Sales allowance incorrectly valued.	1.000	n/1	3.846	.098	1.000	n/1	1.000	n/1	1.000	n/1
Cash Receipts Transactions										
Cash not deposited or recorded.	2.000	n/1	1.000	n/1	4.000	.250	1.000	n/1	1.000	n/1
Cash recorded but not deposited.	4.000	n/1	1.000	n/1	3.692	.150	1.000	n/1	1.000	n/1

TABLE 13 - Continued.

Error Source	Averaged Categorical Responses from Follow-Up Questionnaire (See Table 12 for Categories)													
	Likelihood of a Monetary Error from a Single Source					Likelihood of a Material Error From Related Sources					Largest Error		Largest Irregularity	
	Average	CV	Average	CV	Average	CV	Average	CV	Average	CV	Average	CV	Average	CV
Cash Receipts Transactions - Continued														
Cash deposited but not recorded . . . . .	3.000	.000	2.000	n/1	3.692	.130	1.000	n/1	1.000	n/1	1.000	n/1	1.000	n/1
Cash amount recorded incorrectly . . . . .	3.769	.116	2.000	n/1	2.846	.165	1.000	n/1	1.000	n/1	1.000	n/1	1.000	n/1
Cash credited to wrong sub-account . . . . .	4.923	.211	1.000	n/1	1.000	n/1	1.000	n/1	1.000	n/1	1.000	n/1	1.000	n/1
Cash recorded in wrong period . . . . .	7.000	n/1	5.077	.247	4.615	.300	1.692	.284	1.692	.284	2.154	.417	2.154	.417
Improper recording of interest collected on receivables . . . . .	3.000	n/1	1.000	n/1	1.000	n/1	1.000	n/1	1.000	n/1	1.000	n/1	1.000	n/1
Bad Debt Write-off Transactions														
Collectible accounts written-off . . . . .	5.154	.295	4.000	n/1	1.000	n/1	1.000	n/1	1.000	n/1	1.000	n/1	1.000	n/1
Uncollectible accounts not written-off . . . . .	6.846	.091	6.615	.116	6.308	.209	2.923	.095	2.923	.095	2.846	.132	2.846	.132
Recoveries not recorded . . . . .	1.000	n/1	4.000	n/1	3.769	.116	1.000	n/1	1.000	n/1	1.000	n/1	1.000	n/1
Factoring or Assigning Transactions														
Sale or assignment of receivables not recorded . . . . .	1.000	n/1	6.154	.264	5.231	.249	1.000	n/1	1.000	n/1	1.000	n/1	1.000	n/1
Cash proceeds from sale or assignment not deposited . . . . .	1.000	n/1	5.923	.288	5.538	.351	1.000	n/1	1.000	n/1	1.000	n/1	1.000	n/1
Other Transactions														
Failure to provide adequate product warranty liability . . . . .	6.000	n/1	6.538	.148	6.462	.174	4.077	.339	4.077	.339	3.923	.435	3.923	.435

TABLE 13 - Continued.

Error Source	Averaged Categorical Responses from Follow-Up Questionnaire (See Table 12 for Categories)									
	Likelihood of a Monetary Error from a Single Source		Likelihood of a Material Error From Related Sources		Largest Error		Largest Irregularity			
	Average	CV	Average	CV	Average	CV	Average	CV	Average	CV
Purchases Transactions										
Liability incurred but not recorded. . . . .	6.846	.081	6.692	.166	6.538	.183	4.692	.182	4.692	.182
Purchases recorded but goods not received. . . . .	4.462	.197	4.000	n/1	5.231	.249	2.308	.411	2.923	.295
Purchases incorrectly valued. . . . .	5.538	.216	5.000	n/1	3.154	.295	2.305	3.65	2.646	.195
Purchases incorrectly classified. . . . .	4.769	.092	4.000	n/1	3.846	.144	1.000	n/1	1.000	n/1
Purchases recorded in wrong period. . . . .	6.692	.166	6.077	.264	6.077	.264	4.000	.339	4.308	.347
Purchases Returns & Allow Transactions										
Goods returned but no credit received. . . . .	4.692	.134	4.000	n/1	4.000	n/1	1.000	n/1	1.000	n/1
Credit received but goods not returned. . . . .	2.000	n/1	1.000	n/1	1.000	n/1	1.000	n/1	1.000	n/1
Wrong quantity/price credited for returned goods. . . . .	3.923	.194	2.000	n/1	1.000	n/1	1.000	n/1	1.000	n/1
Wrong period credited for purchases return. . . . .	5.000	.183	4.000	n/1	7.000	n/1	1.923	.333	2.000	.204
Receipt of Goods Transactions										
Damaged or missing goods not reported. . . . .	6.308	.218	3.000	n/1	2.000	n/1	1.846	.300	2.077	.238

TABLE 13 - Continued.

Error Source	Averaged Categorical Responses from Follow-Up Questionnaire (See Table 12 for Categories)									
	Likelihood of a Monetary Error from a Single Source		Likelihood of a Material Error From Related Sources		Largest Error		Largest Error		Largest Irregularity	
	Average	CV	Average	CV	Average	CV	Average	CV	Average	CV
Cash Disbursements Transactions										
Payments recorded but not made. . . . .	3.000	n/1	5.000	n/1	4.395	n/1	1.000	n/1	1.923	n/1
Payment made but not recorded. . . . .	1.000	n/1	4.000	n/1	1.000	n/1	1.000	n/1	1.000	n/1
Payment amounts recorded incorrectly. . . . .	3.846	.098	2.000	n/1	1.000	n/1	1.000	n/1	1.000	n/1
Payment based on incorrect terms or price. . . . .	5.208	.194	2.000	n/1	1.000	n/1	1.000	n/1	1.000	n/1
Payment recorded in wrong period. . . . .	5.615	.186	6.000	n/1	4.000	n/1	2.692	n/1	2.923	n/1
Misrouting of payments. . . . .	2.000	n/1	4.615	.337	5.615	n/1	1.000	n/1	1.000	n/1
Duplicate payments. . . . .	4.846	.277	4.000	n/1	3.000	n/1	1.000	n/1	1.000	n/1
Payment for cancelled orders. . . . .	1.000	n/1	1.000	n/1	1.000	n/1	1.000	n/1	1.000	n/1
Prepayments Transactions										
Prepayments are incorrectly valued. . . . .	2.000	n/1	2.000	n/1	2.000	n/1	1.000	n/1	1.000	n/1
Related prepayment expenses are not properly classified. . . . .	4.769	.126	2.000	n/1	2.000	n/1	1.000	n/1	1.000	n/1
Prepayments are recorded in wrong period. . . . .	3.000	n/1	4.000	n/1	2.000	n/1	1.000	n/1	1.000	n/1
Prepaid items not listed as prepaid. . . . .	6.000	.245	2.000	n/1	2.000	n/1	1.615	.313	1.846	.203
Items listed as prepaid that are not prepaid. . . . .	2.000	n/1	2.000	n/1	1.000	n/1	2.308	.411	2.692	.234
Accruals Transactions										
Failure to include items that should be accrued. . . . .	6.046	.081	6.692	.166	7.000	n/1	4.462	.253	4.615	.243
Accrual of items that should not be accrued. . . . .	4.000	n/1	6.000	n/1	2.000	n/1	3.077	.429	3.538	.273

TABLE 13 - Continued.

Error Source	Averaged Categorical Responses from Follow-Up Questionnaire (See Table 12 for Categories)									
	Likelihood of a Monetary Error from a Single Source		Likelihood of a Material Error From Related Sources		Largest Error		Largest Irregularity			
	Average	CV	Average	CV	Average	CV	Average	CV	Average	CV
Accruals Transactions - Continued										
Accruals incorrectly valued	6.692	.166	6.000	n/1	6.000	n/1	3.692	.279	2.846	.195
Accruals recorded in wrong period	6.538	.183	5.692	.150	6.000	n/1	3.538	.318	3.615	.266
Related expenses not properly classified	5.000	n/1	2.000	n/1	2.000	n/1	1.000	n/1	1.000	n/1
Payroll Transactions										
Employee paid for work not performed	4.077	.255	1.000	n/1	2.000	n/1	1.000	n/1	1.000	n/1
Employee wages calculated using wrong hourly rate	4.000	n/1	1.000	n/1	1.000	n/1	1.000	n/1	1.000	n/1
Employee not paid for hours worked or production completed	3.000	.000	1.000	n/1	1.000	n/1	1.000	n/1	1.000	n/1
Overtime or shift differential hours not recognized	2.000	n/1	1.000	n/1	1.000	n/1	1.000	n/1	1.000	n/1
Employee paid for unauthorized vacation/sick time	2.000	n/1	1.000	n/1	2.000	n/1	1.000	n/1	1.000	n/1
Misappropriation of unclaimed wages	1.000	n/1	1.000	n/1	1.000	n/1	1.000	n/1	1.000	n/1
Mathematical errors in calculation of payroll	4.923	.293	1.000	n/1	1.000	n/1	1.000	n/1	1.000	n/1
Erroneous recording/classification of compensation	3.000	n/1	3.000	n/1	1.000	n/1	1.000	n/1	1.000	n/1
Incorrect handling of end-of-period accruals	5.769	.104	5.000	n/1	4.769	.152	2.846	.316	3.000	.204
Expense reimbursement inaccurately calculated	3.615	.140	1.000	n/1	1.000	n/1	1.000	n/1	1.000	n/1

TABLE 13 - Continued.

Error Source	Averaged Categorical Responses from Follow-Up Questionnaire (See Table 12 for Categories)									
	Likelihood of a Monetary Error from a Single Source		Likelihood of a Material Error From a Single Source		Related Sources		Largest Error			
	Average	CV	Average	CV	Average	CV	Average	CV		
Allocation of Labor Transactions										
Hourly costs of direct labor incorrectly valued. . . . .	3.000	n/1	6.000	n/1	4.000	n/1	1.923	.333	1.923	.257
Hours required to manufacture a unit recorded incorrectly. . . . .	5.000	n/1	6.231	.247	6.000	n/1	1.769	.248	1.077	.258
Labor performed but not correctly allocated. . . . .	1.000	n/1	2.000	n/1	1.000	n/1	1.000	n/1	1.000	n/1
Wages/salaries improperly classified. . . . .	3.000	n/1	4.000	n/1	3.000	n/1	1.769	.248	1.846	.203
Storage Transactions										
Obsolete items maintained in inventory. . . . .	6.615	.169	6.000	n/1	6.923	.040	4.538	.213	4.308	.305
Consigned out items are double counted in inventory. . . . .	3.000	n/1	5.536	.318	2.000	n/1	3.077	.306	3.615	.212
Consigned in items are counted in inventory. . . . .	2.000	n/1	5.923	.243	4.769	.152	3.231	.361	3.538	.273
Raw Mat. to WIP Transactions										
Material requisitions not recorded. . . . .	6.231	.198	4.000	n/1	3.000	n/1	1.769	.248	1.923	.144
Material requisitions are incorrectly recorded. . . . .	5.692	.290	3.154	.176	2.000	n/1	1.000	n/1	1.000	n/1
Material requisitions recorded in wrong period. . . . .	6.154	.218	5.000	n/1	3.000	n/1	1.000	n/1	1.000	n/1
Material requisitions incorrectly classified. . . . .	4.769	.126	2.000	n/1	2.000	n/1	1.000	n/1	1.000	n/1

TABLE 13 - Continued.

Error Source	Averaged Categorical Responses from Follow-Up Questionnaire (See Table 12 for Categories)									
	Likelihood of a Monetary Error from a Single Source		Likelihood of a Material Error From: a Single Source		Related Sources		Largest Error		Largest Irregularity	
	Average	CV	Average	CV	Average	CV	Average	CV	Average	CV
VIP to FG Transactions										
Costs of material, labor and overhead incorrectly recorded . . .	5.000	n/1	5.000	n/1	6.000	n/1	2.154	.458	2.154	.458
Cost of material, labor and overhead incorrectly valued . . .	6.692	.112	5.538	.203	5.692	.195	3.923	.163	3.538	.318
Costs of material, labor and overhead incorrectly classified . . .	3.923	.071	4.000	n/1	1.000	n/1	1.000	n/1	1.000	n/1
Record material, labor and overhead in wrong period . . .	3.000	n/1	5.000	n/1	3.000	n/1	1.923	.257	2.077	.459
Incorrect quantity transferred to finished goods . . .	3.000	n/1	4.000	n/1	2.000	n/1	1.769	.248	2.077	.459
FG to Inventory Transactions										
Incorrect allocation of costs of starting goods . . .	1.000	n/1	2.000	n/1	1.000	n/1	1.000	n/1	1.000	n/1
Finished goods not recorded . . .	3.000	n/1	4.615	.243	1.000	n/1	1.923	.257	2.077	.459
Finished goods recorded at incorrect value . . .	4.000	n/1	5.000	n/1	3.000	n/1	2.154	.458	2.154	.458
Finished goods recorded in wrong period . . .	1.000	n/1	5.077	.284	4.615	.141	1.000	n/1	1.000	n/1
Shipments Transactions										
Quantity shipped does not agree with quantity ordered . . .	5.308	.223	3.000	n/1	2.000	n/1	1.000	n/1	1.000	n/1
Goods shipped different from goods ordered . . .	5.000	.141	2.000	n/1	1.000	n/1	1.000	n/1	1.000	n/1
Goods shipped to fictitious customer . . .	1.000	n/1	5.231	.350	5.077	.260	1.000	n/1	1.000	n/1

TABLE 13 - Continued.

Error Source	Averaged Categorical Responses from Follow-Up Questionnaire (See Table 12 for Categories)									
	Likelihood of a Honorary Error from a Single Source		Likelihood of a Material Error From: a Single Source		Related Sources		Largest Error		Largest Irregularity	
	Average	CV	Average	CV	Average	CV	Average	CV	Average	CV
	3.000	n/1	1.000	n/1	1.000	n/1	1.000	n/1	1.000	n/1
Goods shipped to wrong party.	3.231	.403	5.923	.288	2.000	n/1	1.000	n/1	1.000	n/1
Goods shipped too early or too late.										

Shipments Transactions - Continued

TABLE 14  
 RANGE OF RELATIVE VARIATION IN LIKELIHOOD ASSESSMENTS

Assessed Likelihood of:	Relative Variation in the:	
	Initial Estimates	Follow-up Estimates
Monetary error . . . . .	0.429 - 2.128	0.0 - 0.403
Material error from single source .	0.562 - 3.162	0.116 - 0.350
Material error from related sources	0.525 - 2.999	0.040 - 0.351

accounts. This study is limited to an analysis of monetary errors from a single potential error source which have a material impact on the financial accounts. The effects of monetary errors resulting from related error sources will not be directly addressed.

Note that if two or more single sources of error all affect the same financial accounts, the impact from either single source is identical to some linear combination of the related sources. For example, assume that error sources X, Y and Z each result in monetary errors which overstate gross sales and accounts receivable. The impact of seeding a material error (abbreviated as  $M_o$ ) from source X is identical to seeding  $aM_o$  from source X,  $bM_o$  from source Y and  $cM_o$  from source Z, where a, b and c sum to one. This special case of the impact of related error sources is implicitly considered during the analysis of impacts from a single error source.

#### Largest expected monetary errors

The largest expected monetary errors were assessed as a percentage of net income before tax. The averaged responses for each of 106 error sources are presented in Table 11. For each error source, the coefficient of variation for the averaged responses is also presented.

The objective of asking the question was to find a materiality range over which the alternative analytical procedures need to be effective. Thus, the individual estimates need to be converted to multiples of materiality. This was accomplished by dividing each participant's assessment by the percentage of net income before tax that the participant deemed material. The responses converted to materiality units will be referred to as

"adjusted responses."

Kendall's coefficient of concordance was calculated to determine the degree of concordance among the participants' adjusted responses. This provides a measure of the relative agreement of the participants concerning the size of the largest expected error and irregularity, expressed in units of a material amount, across the 106 error sources. The derived test statistics are 0.0519 for the largest accounting error and 0.0259 for the largest accounting irregularity. If random selection and probability sampling had been used, a null hypothesis of no associations would be accepted. This implies that auditors are not in general agreement as to the size of monetary errors which could result from potential error sources.

A nonstatistical analysis was applied to the individual responses to detect any patterns which implied firm or location effects. Such patterns were not detected. However, this analysis did reveal the following:

a. In eighty-five percent of the distributions of individual responses by error source, eleven or more of the individual assessments were less than two times a material amount. Many of the assessments greater than two times a material amount were provided by the same two participants.

b. Fifteen percent of the distributions of individual responses by error source were bimodal in nature. In the lower tails of the distributions, the responses tended to cluster at one half a material amount. In the upper tails, the responses tended to be uniformly distributed between four and ten times a material amount. The highest assessments could normally be attributed to two individuals. A distribution was considered bi-modal if three or more individual responses exceeded two times a material amount.

c. The participants' opinions varied as to whether a monetary error source would result from an accounting error, an accounting irregularity, both or none. This difference in opinion appears to account for the wide variation in the responses. Some participants believed that a particular error source would result in a material accounting error. Others believed that the error source would not result in an accounting error at all, while still others believed that a small accounting error could occur. No patterns could be detected which would relate a specific group of auditors with the large assessments.

d. It was originally speculated that the size of an irregularity would exceed the size of an error. This is not the case in all situations. When an error occurs with a high frequency, the aggregate of all the small errors can exceed the aggregate of the irregularities.

Because of the distributions of the individual responses, the median value, rather than the averaged value, was used to represent the consensus opinion. The error sources were categorized according to median values. Interval sizes of one-half a material amount were chosen to maintain consistent error magnitudes. This resulted in five categories, with the highest category representing error sizes from 2.0 to 4.0 times a material amount.

The participants were asked to corroborate the monetary error sources which could result in accounting errors or accounting irregularities exceeding one-half a material amount. Since there was general consensus on those error sources with monetary error sizes of less than one-half a material amount, these were not corroborated. The corroboration process is presented in section II, part C of Appendix D, Follow-up Questionnaire.

Note that this corroborative process is presented in a

different form than the original assessments. The participants are asked if the classifications of the largest expected monetary errors resulting from a potential source seems reasonable. The classifications are expressed in multiples of a material amount rather than the percentages of net income used during the initial estimates.

The revised categorizations of error sources by the largest expected size of accounting error and accounting irregularity are presented in Table 13. Coefficients of variation are presented for those categories representing errors which are greater than one-half a material amount. Error sources in the lowest category were not corroborated. Eighty three percent of the 106 error sources are expected to result in accounting errors which are less than a material amount (values of 1 to 2.5 in Table 13), while eighty percent are expected to result in accounting irregularities which are less than a material amount. Note that these results address the monetary size of the errors. Many auditors will contend that any irregularity, regardless of its size, is material. These results are not intended to imply that irregularities which are less than a material amount are not material. The results merely correlate the size of the monetary errors with the potential sources.

Upon initial analysis, there appears to be some inconsistencies between the likelihood that an error source will produce a material monetary error and the largest expected size of the resulting monetary error. For example, the error source "goods returned but not reentered into inventory system" is expected to result in a material monetary error in four to six percent of all audits (A value of 4.5 - 5.5 in the "Likelihood of a Material Error from a Single Source" column in Table 13), yet the size of the

largest expected error or irregularity is less than a material amount (A value of 1.0 - 1.5 in the "Largest Error" and "Largest Irregularity" columns in table 13). A similar situation occurs in twenty-six other error sources where the likelihood of a material monetary error from the single source is greater than four percent, yet the largest expected size of the error is less than a material amount.

No instances of the opposite situation occur. Hence, there is a positive association between the expected size of an error or irregularity being greater than a material amount and a likelihood of a material monetary error greater than four percent for the error sources.

One possible explanation for the apparent inconsistencies relates to the concept of materiality. The participants were asked to provide a single point estimate of the monetary amount they considered material. The point estimates of the largest error sizes were expressed as a percentage of net income, and converted into multiples of materiality by dividing by the general materiality threshold estimate. It is speculated that the general materiality threshold caused the inconsistencies. Some monetary errors are considered more important by the auditors than others. In these situations, the general materiality threshold is no longer valid.

Expressing the error sizes as percentages of net income may eliminate this inconsistency. However, the amount of net income that each auditor considers material varies from two to ten percent. So expressing error sizes as a percentage of net income would still produce inconsistent generalizations to materiality.

Monthly distribution of  
monetary errors

Any pattern in the monthly distribution of monetary errors should be related to the type of error which causes them. The types of errors used in this study include cutoff, classification, valuation, recording and other. The individual responses of the participants for each potential error source were categorized by error type and then averaged within each category.

To corroborate these assessments, the participants were provided this information as feedback and asked if the results seemed reasonable. The tabularized results are shown in section II, part A of Appendix D, Follow-up Questionnaire. If specific results did not seem reasonable, the participants were asked to change the table to reflect their opinion as to the reasonable monthly distributions of monetary errors.

The comments pertaining to the averaged responses of the monthly distributions of monetary errors were limited to valuation types of errors. Several auditors indicated that the reported distribution of the valuation errors was not reasonable. The major changes resulting from aggregating the revised estimates were a ten percent increase in valuation errors occurring at the end of periods and a seven percent decrease in valuation errors occurring with no specific pattern. The revised results are presented in Table 15.

Analysis of Table 15 suggests:

- a. The percentage of monetary errors which occur strictly during a single quarter is significantly lower than the other categories. This would imply that seasonal fluctuations are not very pronounced in the manufacturing industry.

TABLE 15  
MONTHLY DISTRIBUTION OF MONETARY ERRORS

Type of Error	Single Month	Single Quarter	Evenly Dispersed	No Specific Pattern	End of Period
Cutoff . . . .	7%	0	25%	21%	47%
Classification	11%	1%	38%	37%	13%
Valuation . . .	15%	1%	29%	38%	17%
Recording . . .	12%	2%	32%	38%	16%

b. Cutoff errors tend to be distributed at the end of interim periods, as would be expected. Cutoff errors also occur systematically at the end of each month, or with no specific pattern, occurring in some months but not in others.

c. Classification and recording errors tend to be either systematic, occurring in each month, or with no specific pattern, occurring in some months but not in others.

d. Valuation errors tend to have no specific pattern of occurrence. Such errors may occur systematically in each month, or at the end of each interim period.

In general, errors tend to occur either systematically throughout the period or with no specific pattern. With the exception of cutoff errors, more than 70 percent of the errors are distributed in accordance with these two conditions. As suggested in Chapter 3, this result was expected. With the exception of cutoff errors, the remaining monetary errors are essentially equally distributed at the end of periods or within a single month.

These results imply that caution is warranted when applying auditing techniques in which the effectiveness of the technique is sensitive to the monthly distribution of errors. If a technique becomes less effective as the distribution of the error becomes more disperse, then that technique should not be applied to detect systematic errors. The majority of the errors are expected to be distributed across the monthly accounts. In the case where errors are equally distributed over all the months in the audit period, systematic biases in the results of audit tests would be expected. The direction and magnitude of the biases depends on the average size and direction of the resulting monetary errors. In the case where errors are distributed with no specific patterns, it becomes

more difficult to distinguish the monetary errors from normal business fluctuations.

Use in simulation model. The results presented in table 15 provide the basis for selecting the error conditions to be included in the specific simulation model. The error condition where the monetary error is distributed within a single quarter will not be included in the analysis due to the extremely low likelihood of occurrence. This leaves six error conditions which will be evaluated: (a) all errors occurring in a single month, designated "1 month," (b) all errors occurring at the end of each interim period, designated "period end," (c) errors evenly dispersed in each month of the audit period, designated "all months," and (d-f) errors occurring in any two, three or four randomly selected months, designated "2 months," "3 months" and "4 months," respectively.

Where the specified monetary error is seeded into more than one month, the errors will be evenly distributed across those months. This is considered to be the worst case situation when detecting material errors within the financial accounts. Analysis of Table 15 also indicates that the above error conditions cannot be isolated to specific error types. Thus, each seeded monetary error will be distributed according to each of the six error conditions.

#### Analysis and Implications

In Appendix E, the relationships between the potential sources of monetary error and the financial relationships are presented. An "X" indicates that the financial relationship includes at least one financial account which is either directly or indirectly affected by the monetary error source. A review of Appendix E reveals that monetary errors resulting from a single

source will affect the analysis of numerous financial relationships.

An indication of the likelihood that a material error will result from a particular source is provided in Appendix E. For individual error sources, the likelihood category represents the assessed probability that a monetary error resulted from the error source and that the monetary error has a material impact on the financial statements.

The likelihood categories are derived from the products of the frequencies of occurrence in Table 13. The first step was to convert the ordinal categorization of each error source back into a ratio scale. This was accomplished by interpolating the interval for a category using the averaged categorical responses listed in Table 13. For example, the averaged categorized responses for the error source "wrong period credited for sale" are 6.538 for the likelihood of a monetary error occurring,  $P(E)$ , and 6.0 for the likelihood that the occurring error is material,  $P(M|E)$ . Reference to Table 12 provides the intervals for the various categories. For  $P(E)$ , the interval is 0.36 to 0.73. This produces a range of 0.37 for the category width of 0.5 (7.0-6.5). The interpolated value of  $P(E)$  is calculated as:  $0.36 + \{(6.538 - 6.5) \times [0.37 / (7.0 - 6.5)]\} = 0.388$ . For  $P(M|E)$ , the interval is .06 - .12, producing a range of 0.06. The interpolated value of  $P(M|E)$  is calculated as:  $0.06 + \{(6.0 - 5.5) \times [0.06 / (6.5 - 5.5)]\} = 0.09$ . The product of the two estimated probabilities, 0.0349, indicates the joint probability that a monetary error results from the error source and that the monetary error is material.

The likelihood categories represent intervals of one percent. In other words, category 1 includes probabilities ranging from 0 to 0.01, category 2 includes probabilities ranging from 0.01 to 0.02,

etc. The estimated probability calculated in the above example lies in category 4 (0.03 to 0.04). The largest category is 10, implying that the chance that an error source will result in a monetary error that is material on any given audit is not greater than 10 percent.

Classifications for the likelihood that the aggregated error resulting from related sources of error is material were formed from the products of estimated probabilities interpolated from Table 13 in a similiar manner. The same classification intervals were used.

An alternative approach would be to use the midpoint of the intervals as the estimated probabilities. The interpolation process should produce more accurate estimates since it weights each error source by its relative position within the interval.

Analysis of the information provided in Appendix E reveals that certain types of errors are not detected by the financial relationships presented; namely, certain classification errors. All of these errors are in the lowest two likelihood classifications, implying that material errors would result from these error in less than two percent of all audits. The reason that such errors are not analyzed is that the financial relationships are oriented toward functional categories. Hence, if material classification errors are expected, the auditor must extend the analytical procedures to include analysis of the sub-accounts within functional categories.

The extent of the relationships between the error sources and the financial relationships suggest that increased detail may be required before analytical review procedures can be used as a substitute for detailed tests of transactions and balances. For example, eighty-three error sources can impact the current ratio.

If an analytical procedure involving the current ratio indicates that additional investigations are required, the auditor can eliminate only 23 of the 106 possible sources of error. Some form of triangulation process must be incorporated with the analytical review procedures to attempt to identify the most likely sources of error for additional investigation.<sup>17</sup>

Another potential problem exists due to offsetting errors. If an analytical review procedure involving the current ratio indicates that the expected audit value is within the acceptable limits, one cannot conclude that no material errors are present. There could be numerous material errors which offset each other. Again, this suggests that a lower level of analysis may be required for analytical review. While this would not eliminate the potential for offsetting errors from a single source, it could reduce or eliminate offsetting errors from related sources.

The data presented in Appendix E has some implications for audit planning and internal control systems. Certain error sources are more likely to produce material monetary errors than others. From an auditing viewpoint, it is important that adequate accounting controls exist to prevent the resulting monetary errors from entering the financial accounts. Those areas requiring increased emphasis include:

- a. Reconciliation of shipping documents and sales invoices to ensure that goods are shipped for all recorded sales.
- b. Establishment of and compliance with procedures for recognizing revenue. Such procedures should include proper recording of sales, cash receipts, and sales returns.
- c. Establishment of and compliance with procedures for

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<sup>17</sup>See Chapter 5 for a discussion of triangulation.

writing-off uncollectible accounts.

- d. Ensuring adequate provisions for product warranty liabilities.
- e. Establishment of and compliance with procedures for recognizing and recording liabilities. This review should include an analysis of the organizational structure to determine which individuals have the authority to commit the firm to a liability.
- f. Establishment of and compliance with procedures for recording purchases and purchase returns.
- g. Establishment of and compliance with procedures for establishing and recording accruals.
- h. Establishment of and compliance with procedures for removing obsolete and defective items from inventory.

#### Summary

This chapter detailed the collection strategy for gathering the empirical information for the study. The needed information was assessed from experts since it was not feasible to gather it directly from existing records.

The survey population was defined as partners and managers from two Big Eight public accounting firms within four geographical areas. The participants were systematically selected on the basis of their experience in auditing medium-sized manufacturing firms. This survey population should represent a population of auditors who are experienced in the auditing processes applied to medium-sized manufacturing firms.

The needed information was assessed from the participants using an estimate-feedback-estimate method. Initial estimates were gathered from each participant for each research question during a personal interview. Where excessive variation existed, the results

of the initial estimates were provided to the participants as feedback in the form of a follow-up questionnaire. The participants were then asked to re-assess their opinions incorporating the feedback information. Additionally, the participants were asked to provide their opinions as to what caused the excessive variations in the initial estimates.

The results of the initial and follow-up assessments were analyzed to show the relationships between the financial relationships typically analyzed during an audit of a medium-sized manufacturing firm and the potential sources of error. It was evident that the analytical relationships typically analyzed by practicing auditors have the capability of detecting almost all of the monetary errors which enter the financial statements during the processing of transactions. But the analysis thus far does not provide any evidence concerning the relative effectiveness of the alternative analytical procedures which could be used. This area will be investigated in the next chapter.

## CHAPTER V

### ANALYSIS OF RESULTS

#### Introduction

The results derived from the simulation process are used to develop guidelines for selecting analytical review procedures. The use of these guidelines requires the following conditions:

a. The auditor is able to rely on the system of internal accounting control, which implies that the auditor can rely on the evidence obtained from applying analytical review procedures during the audit.

b. The auditor plans to rely on the evidence provided by the analytical review procedures to reduce the extent of detailed tests of transactions and balances, thereby minimizing overall audit costs. The implication of this condition is that the maximum allowable risk of incorrect acceptance for analytical review procedures (AR) is less than 100 percent. If AR is set at 100 percent, the allowable risk of incorrect acceptance for tests of details (TD) must be set at lower levels to maintain the allowable level of ultimate risk (UR). This defeats the objective of using analytical review procedures to reduce the extent of detailed tests.

c. The auditor is able to assess the likelihood of material monetary errors occurring in the financial accounts during the periods of planning and evaluation of the system of internal control. It is further assumed that these likelihood assessments of

monetary error include an analysis of the potential sources of error and whether the occurrence of such errors tend to be random, occurring in a few months, or systematic, occurring in most months.

Under the above conditions, the auditor may use the associations presented in Appendix E to determine which set of financial relationships could be applied to detect the presence of material monetary errors assessed most likely to occur within the client's financial data. However, no information is provided to the auditor to allow evaluation of the effectiveness and efficiency of the resulting analytical procedure. Additional information must be incorporated into Appendix E which allows the auditor to select an analytical technique to apply to the financial relationship and select a decision rule to evaluate the results. The selection guidelines developed in this chapter will incorporate such additional information.

The first section of this chapter will define the parameters that an auditor should consider during selection of the analytical review procedures. The results of the simulation process will then be analyzed to assess the effects of the selection parameters on the efficiency and effectiveness of the analytical review procedures. Those parameters which have a significant influence will be incorporated with a subset of the data provided in appendix E to produce general selection guidelines for the potential monetary error sources most likely to occur during an audit of a medium-sized manufacturing firm.

#### Selection Parameters

Given that the auditor can select a set of financial relationships which provide adequate coverage of the potential sources of error in the financial data, the analytical technique/

decision rule (hereafter referred to as the "analytic test") to be applied to the financial relationships must be determined.

#### Specifying the maximum AR

The first selection parameter concerns specifying the maximum AR, or risk of incorrect acceptance for analytical review procedures. The relationships between the levels of AR, TD and the risk that internal accounting control might fail to detect a material error (IC) that maintain UR at five percent are shown in Figure 5. Each curve in Figure 5 shows the tradeoff between AR and TD at specified levels of IC. For example, if TD is set at 50 percent and IC is estimated at 30 percent, then to maintain UR at five percent AR must be set to approximately 33 percent (as calculated in Chapter 3). Figure 5 shows that the selection of the maximum level of AR that maintains UR at five percent involves tradeoffs between the estimated IC and the desired level of TD.

One of the conditions for use of analytical review specified above is that the auditor can rely on the system of internal control. Hence, this study assumes that IC will be 30 percent or less. Review of Figure 5 indicates that analytical review procedures become less cost effective at levels of IC greater than 30 percent. Assume that AR is set at 50 percent. If IC equals 50 percent, use of analytical review procedures will allow a 10 percent reduction in TD, from 10 percent to 20 percent. If IC equals 30 percent, the reduction in TD is 18 percent, from 16 percent to 34 percent. Hence, there is greater cost effectiveness of analytical review procedures at lower levels of IC.

The data depicted in Figure 5 suggest that levels of AR greater than 75 percent become less cost effective. The slopes of the isographs are approximately equal for levels of AR greater than 75

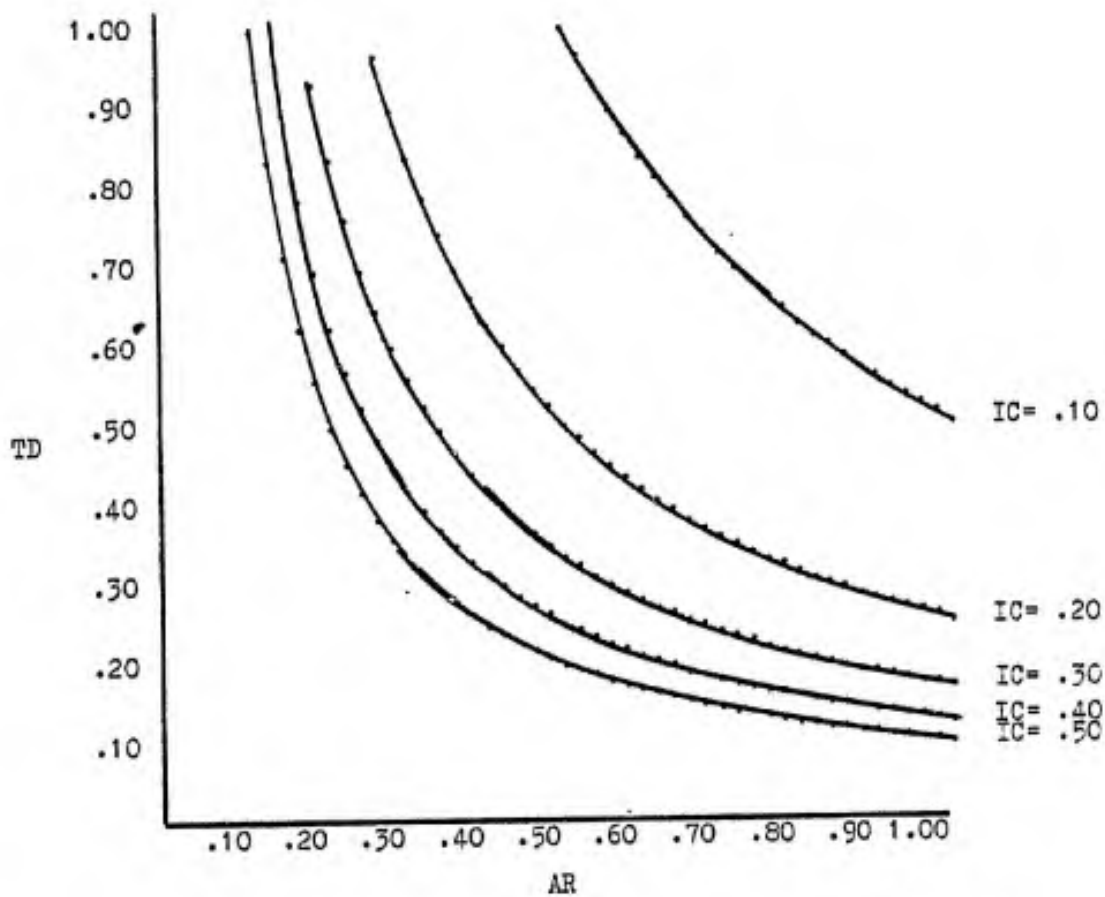


Fig. 5. Allowable risk of incorrect acceptance (TD) for various assessments of IC and AR for  $UR=0.05$ .

percent and values of IC greater than 30 percent. The application of analytical review procedures under such conditions produces relatively small decreases in the levels of TD.

Levels of AR less than 50 percent were assumed to be too restrictive within this study. As discussed later in this chapter, some analytical review procedures will not consistently meet effectiveness levels that are less than 50 percent. Hence, 50 percent appears to be the minimum level of AR that permits auditors to apply alternative analytical review procedures and reduce the extent of substantive testing.

In this study, maximum AR is set at 62.5 percent. This level of AR does allow decreases in the level of TD when IC is 30 percent or less. The level of AR is also large enough to allow the use of most analytical review procedures evaluated within this study.

#### Specifying the test cutoff

The next selection parameter concerns the cutoff for the analytic test. In this study, three cutoffs are evaluated for each analytic test: monthly, interim point-in-time, and end of period point-in-time. If monthly financial information is not available, a point-in-time cutoff test may be required. In this situation, the auditor is concerned with the efficiency and effectiveness of the interim tests compared to the end of period tests. If monthly data is available, the auditor is concerned with whether the monthly tests are more reliable than the point-in-time tests.

#### Assess characteristics of possible errors

Certain characteristics of the monetary errors may influence the efficiency and effectiveness of the analytic tests. The significance of the influence should be assessed and considered

during selection of the analytic test. These characteristics include:

a. Differences in the financial data subject to analysis. These differences could result from analyzing alternative time periods for the same client, or analyzing different clients.

b. Differences in the size of the monetary error expected to occur in the financial accounts. Differences can exist in terms of the absolute size (expressed as multiples of a material amount) or in the direction of the error (expressed as overstatements and understatements).

c. Differences in the monthly distribution of the error across the financial accounts. Such distributions can be classified as random, occurring only in a few months, or systematic, occurring in most months.

Once the analytic test is selected, an assessment should be made of the significance of the possible differences in error characteristics as they affect effectiveness and efficiency when applied to alternative financial relationships. The overall effectiveness level for analytical review procedures will be the maximum type II error rate for the analytic test applied to the alternative financial relationships. This overall effectiveness level must be less than the specified maximum AR.

#### Selection of the precision interval

Changes in the precision interval incorporated into the decision rule may influence the reliability of the analytical procedure. The decision rules included in this study were assumed to meet an intermediate level of reliability. The use of low and high reliability levels or the use of wider/narrower precision may

influence the overall efficiency and effectiveness of the analytic tests.

#### Selection of analytical review procedures

An auditor could design analytical review procedures by selecting the most efficient analytic test that meets maximum AR for each financial relationship analyzed. However, this study assumes that the auditor will select the analytic test with the best efficiency (type I error rate) that meets maximum AR (type II error rate less than 62.5 percent), and apply it consistently across a set of financial relationships. Hence, this study designs analytical review procedures by selecting the most reliable analytic test across a set of financial relationships and combining the analytic test with those financial relationships.

#### Analysis of Results

The large amount of data in the simulation process in this study necessitates the use of statistical models to evaluate the underlying relationships in the data. It must be emphasized that this study is descriptive in nature, and is not intended to represent an experimental process. Hence, many of the statistical and experimental controls necessary to justify the use of parametric statistical models are not incorporated into this study. The implication is that parametric statistical models cannot be used to investigate cause and effect relationships or to test hypotheses in this study. However, such models can still be employed to investigate the structural relationships in the data and nonparametric models can be used to evaluate the significance of the structural relationships.

The first part of this section will define the statistical models used and the underlying assumptions of the models. The models will then be applied to the simulation results to analyze the effects of cutoff test, firm and time period, monetary errors, financial relationship and decision rule reliability level on the type I and type II error rates.

#### Statistical models and assumptions

A nonparametric two-way analysis of variance by ranks, an associated multiple comparison procedure, and a nonparametric measure of the strength of agreement will be used to evaluate the statistical significance of the underlying structural relationships in the results obtained from the simulation process. These nonparametric tests allow statistical testing of whether population distributions of unspecified form are exactly alike. Parametric tests compare the population parameters. Since the nonparametric procedures analyze the population distribution rather than population parameters, it is not necessary to assume that the underlying populations are normal with equal variances.

The major disadvantages of applying nonparametric procedures are:

- a. The power of the nonparametric designs is less than than of parametric designs when the assumptions of the parametric designs are fulfilled.
- b. The nonparametric designs do not extract as much information from the data as comparable parametric designs when the assumptions of the parametric designs are fulfilled.
- c. Multitreatment (more than two) nonparametric analysis of variance is not available.

The nonparametric tests are appropriate under the following conditions:

- a. One treatment is evaluated with two or more levels. (Actually, the Friedman test is appropriate for three or more levels. The Wilcoxon test will be used when the treatment has only two levels. Although computationally different, the underlying assumptions of the two tests are similar.)
- b. The treatment levels are randomly assigned across the blocks.
- c. The variables of interest have continuous probability distributions.
- d. The observations contain at least ordinal information concerning the effects of the treatment.<sup>1</sup>

The nonparametric tests applied within this study evaluate whether the effects of multiple treatments across blocks are identical. The blocks represent the alternative analytic tests. The observations within each block are the averaged type I and type II error rates which result when the analytic tests are coupled with different financial relationships and applied to financial data sets reflecting various monetary error conditions. For error conditions where the total monetary error is less than a material amount, the type I error rate represents the number of observations where an investigation was signalled divided by the total number of observations. For error conditions where the total monetary error equals or exceeds a material amount, the type II error rate represents the number of observations where an investigation was not signalled divided by the total number of observations. Since these percentage values are expressed along a ratio scale, the

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<sup>1</sup>Roger E. Kirk, Experimental Design: Procedures for the Behavioral Sciences (Belmont, CA.: Brooks/Cole Publishing Co., 1968), p. 503.

measurements are continuous. Thus, conditions (c) and (d) above are satisfied.

The treatments (cutoff, firm and time period, error size, error distribution, and decision rule reliability level) are categorical in nature. Each treatment has three or more fixed levels, meeting condition (a) above. Each analytic test is evaluated at each level of each treatment. Thus, a complete block design is used with independent measurements for each analytic test across the treatment. However, random assignment of the treatment levels across the blocks (condition (b) above) was not used.

One of the basic assumptions for both parametric and nonparametric statistical analysis is randomization in the experimental design. In general, the purpose of randomization is to distribute the effects of all uncontrolled variables in such a way that they can be taken into account in the tests of significance. The effects of the uncontrolled variables are spread out so that all groups are affected in the same manner, thus allowing valid comparisons between groups. In most experiments, one can never be certain that some variable that has been overlooked will not bias the evaluation of the experiment. Thus, randomization is necessary in the design of the experiment.

With the discrete simulation process used in this study, all controlled variables are fixed at specified levels (with the exception of selecting two, three or four random months for certain error distribution conditions.) Within the simulation process itself, there should not be any uncontrolled variables. Replications of the simulation model using the same input parameters would produce identical results. Thus, not using a completely randomized design should not have a significant impact on the probabilities associated with the tests of significance.

Uncontrolled variables may affect the selection of treatments and the validity of the specified treatment levels. This implies that the results of the simulation process cannot be generalized, statistically, outside of the two firms, two audit periods per firm, and monetary error characteristics and analytical procedures analyzed.

The Friedman test is used to statistically evaluate the null hypothesis that the populations within a block (analytic test) are identical. Rejecting the null hypothesis indicates a difference in the type I and type II error rates for the analytic tests among the levels of the treatment. This does not provide any indication of where the differences are located.<sup>2</sup>

The associated multiple comparison procedure statistically evaluates all possible differences between pairs of treatment levels. The results indicate whether the difference between two levels of the treatment may be considered statistically significant.<sup>3</sup> Assume that the treatment has three levels: A, B and C. Further assume that the results of the multiple comparison conclude that levels A and B yield different results, levels B and C yield different results, but methods A and C do not yield different results. These results imply that level B is significantly different from levels A and C, but do not provide any indication of the direction of the difference.

Parametric statistics may be used to assess the direction of any trends identified by the multiple comparisons procedure. The statistics employed will be the mean and the standard deviation of

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<sup>2</sup>Daniel, pp. 224-28.

<sup>3</sup>Ibid., p. 231.

the measurements within each cell of the two-way model. A cell is defined by the combinations of analytic tests and treatment levels. Changes in the mean across the treatment levels will allow assessment of the direction of the trends. The standard deviation is used as a measure of the dispersion about the mean. If the dispersion about the means across the treatment levels is consistent, then there is increased confidence in the trend suggested by the means.

While the above procedure is useful to identify significant trends across the analytic test and each treatment, it does not provide any indication of the relative significance across the different treatments. The coefficient of variation allows an assessment of the dispersion of an entire set of data with the dispersion of another set of data. Hence, the coefficient of variation can be used to assess the relative variation among the treatments.

The parametric statistics assume that the measurements are normally distributed within each treatment population. The smallest population size within a cell in this study contains 216 observations. It is assumed that a population of 216 observations is sufficiently large for the assumption of a normal sampling distribution to be appropriate.

For the analysis of the effects of the direction of the monetary error, the Wilcoxon matched-pairs signed-ranks test will be used. Only two treatment levels are available for the direction of the error: understatement or overstatement. The Wilcoxon test is appropriate for testing the differences in the location of two related populations. The test statistic is derived from the differences between the two populations and assumes that the differences are on at least an interval scale. Since the

observations are on a ratio scale, this assumption is met. The Wilcoxon test also assumes that the distribution of the population of differences is symmetric.<sup>4</sup> Visual inspection of the data was used to verify this condition for applying the test.

Kendall's coefficient of concordance is used to measure the strength of the agreement among the relative reliabilities of analytic tests across financial relationships. This provides an indication of whether the same analytic test is associated with the lowest type I error rate and highest type II error rate across the financial relationships. The test statistic ranges from zero to one, with zero indicating a total absence of association and one indicating perfect association among the set of rankings. The assumptions for this test are less stringent than those discussed above for nonparametric tests. Therefore, they are met in this study.<sup>5</sup>

A consideration when applying statistical tests is that the overall reliability level for the experiment is dependent on the total number of a-priori comparisons made. As the number of independent comparisons increases, the probability of at least one spuriously significant result also increases. Within this study, ten independent a-priori comparisons were applied. Each a-priori comparison was evaluated at a reliability level of 97.5 percent. This produces an overall reliability level of approximately 78 percent. The multiple comparison procedure adjusts the reliability level of each comparison to maintain a test-wise reliability level of 97.5 percent.

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<sup>4</sup>Ibid., pp. 135-39.

<sup>5</sup>Ibid., pp. 326-31.

Relationship between type I and  
type II error rates

The results of this study are presented in terms of type I and type II error rates. Hence, it is important to discuss the relationships between the type I and type II error rates. Figure 6 will be used to illustrate these relationships by showing the number of investigations signalled as the size of the monetary error changes.

Figure 6 shows the balances of a hypothetical account for four months: January, April, July and October. The solid line across the graph represents the predicted values of the monthly balances while the dotted lines represent the precision interval corresponding to a precision of a material amount for the analytic test. The "\*" represents the true monthly balance of the account and the values above the "\*" depict monetary errors in multiples of a material amount. Investigations are signalled when the balance of an account (true value plus the monetary error) exceeds the precision of the analytic test.

The month of April illustrates the situation when the predicted balance is close to the true balance. Investigations are signalled in April for the monthly balances containing errors for 1.0, 1.5 and 2.0 times a material amount. No investigations are signalled when the amount of monetary error is less than a material amount (0.0, 0.5 and 0.8 times a material amount). This information is presented in Table 16. Table 16 also provides the type I and type II error rates for the month of April. Both values are zero.

The month of January illustrates the situation where the predicted balance is greater than the true balance by two times the precision of the analytic test. Investigations are signalled when

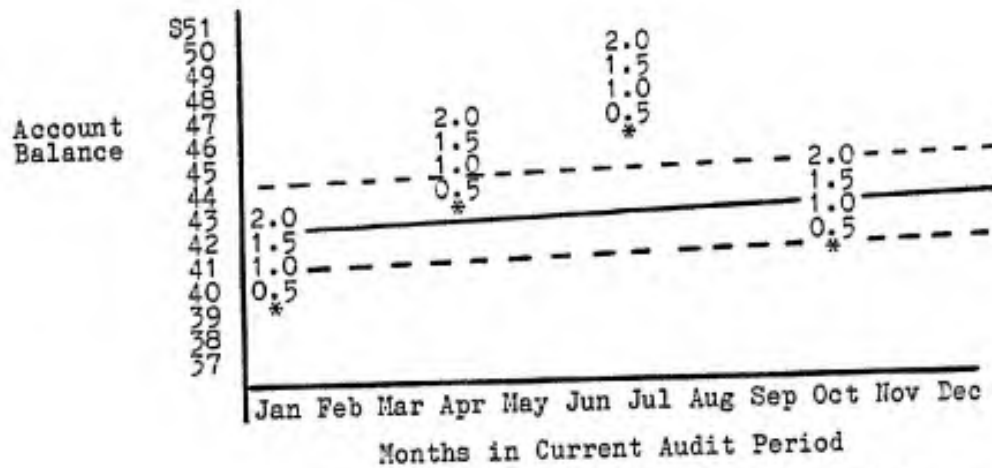


Figure 6. Investigations signalled as monetary error increases from zero to two times a material amount.

TABLE 16  
 ERROR RATES ASSOCIATED WITH THE ANALYSIS OF MONTHLY  
 FINANCIAL BALANCES DEPICTED IN FIGURE 4

Amount of Error:	Month Evaluated				
	Jan.	Apr.	July	Oct.	Overall
Is less than a material amount:					
Investigations not signalled . . . . .	0	3	0	2	5
Investigations signalled . . . . .	3	0	3	1	7
Type I error rate . . . . .	100%	0%	100%	33%	58%
Equals or exceeds a material amount:					
Investigations not signalled . . . . .	3	0	0	2	5
Investigations signalled . . . . .	0	3	3	1	7
Type II error rate . . . . .	100%	0%	0%	66%	42%

the amount of error is less than a material amount, but are not signalled when material errors are present. As shown in Table 16, the resulting type I and type II error rates are both 100 percent.

The month of July illustrates the situation where the true balance exceeds the predicted balance by more than the precision of the analytic test. Investigations are signalled for all error conditions resulting in a type I error rate of 100 percent and a type II error rate of zero.

Finally, the month of October illustrates the situation where the true balance is less than the predicted balance by an amount equal to the precision of the analytic test. Two investigations are signalled; one at no error and one at an error equal to two times a material amount. This produces a type I error rate of 33 percent and a type II error rate of 66 percent.

Combining the effects over all four months produces an average type I error rate of 58 percent and a type II error rate of 42 percent. The standard deviations of these error rates are both approximately 0.50. While the average type II error rate is less than the maximum AR (62.5 percent), there is only 66 percent confidence that analytical review procedures applied to the data depicted in Figure 4 will be less than maximum AR. Thus, aggregating the error rates across the individual months can produce deceptive results, and requires analysis of the dispersion of the error rates as well as the average.

This brief discussion of the relationship between type I and type II errors has illustrated the importance of evaluating the dispersion of the error rates as well as the averaged rate. The results of the simulation process are now discussed.

Analysis of cutoff test effects

The overall reliability of the analytic tests evaluated at the various cutoff points within the study is summarized in Table 17. The type I error rate is used as the measure of efficiency and the type II error rate is used as the measure of effectiveness. The error rates associated with each analytic test presented in Table 17 are averaged across the remaining simulation control parameters; namely: firm, time period, error size, error distribution, financial relationship and source of monetary error. The standard deviation provides an indication of the dispersion among the error rates associated with the analytic tests.

The results presented in Table 17 indicate that, with respect to the monthly cutoff tests evaluated in this study, the auditor can be at least 94 percent confident that the materiality-based (numerator benchmark, denominator benchmark, and material change) and statistical (regression and time series) decision rules will meet the maximum level of AR (62.5 percent). The monthly 10 percent change, yearly change and monthly change analytic tests meet this maximum effectiveness level at 74, 73 and 61 percent confidence, respectively.<sup>6</sup>

With respect to point-in-time tests, the denominator benchmark, material change and numerator benchmark analytic tests provide at least 87, 85 and 83 percent confidence, respectively, that the maximum effectiveness will be less than the specified AR. The analytic tests which incorporate traditional decision rules (10 percent change and yearly change) provide at least 62 percent confidence that maximum AR will be met.

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<sup>6</sup>See Chapter 4, pp. 136-41.

TABLE 17  
EFFECT OF CUTOFF ON THE AVERAGED  
ERROR RATES OF ANALYTIC TESTS

Analytic Tests	Type I		Type II		Conf. Level that AR in net
	Average	Std. Dev.	Average	Std. Dev.	
	Monthly Cutoff Tests				
Financial Ratios					
Numerator Benchmark . . . . .	.837	.274	.111	.217	.991
Denominator Benchmark . . . . .	.866	.245	.100	.217	.992
10% Percent Change . . . . .	.626	.374	.377	.377	.744
Regression . . . . .	.691	.351	.176	.281	.945
Individual Accounts					
Material Change . . . . .	.700	.302	.205	.260	.947
Yearly Change . . . . .	.584	.347	.413	.353	.726
Monthly Change . . . . .	.269	.252	.766	.282	.613
Time Series . . . . .	.768	.310	.120	.229	.986
September Point-in-Time Tests					
Financial Ratios					
Numerator Benchmark . . . . .	.754	.429	.233	.418	.826
Denominator Benchmark . . . . .	.818	.384	.186	.386	.872
10% Percent Change . . . . .	.544	.498	.464	.497	.627
Individual Accounts					
Material Change . . . . .	.826	.376	.198	.359	.903
Yearly Change . . . . .	.574	.494	.413	.490	.667
December Point-in-Time Tests					
Financial Ratios					
Numerator Benchmark . . . . .	.809	.393	.186	.300	.871
Denominator Benchmark . . . . .	.830	.374	.161	.365	.898
10% Percent Change . . . . .	.593	.491	.411	.491	.668
Individual Accounts					
Material Change . . . . .	.778	.415	.212	.405	.846
Yearly Change . . . . .	.527	.499	.463	.496	.628

The superiority of statistical and materiality-based decision rules implies that auditors should incorporate such rules into their analytical review procedures. These results do not suggest that the traditional techniques currently applied by practicing auditors are invalid. As discussed later, the largest amount of variation in the error rates is due to the financial relationship analyzed. Application of traditional techniques to specific financial relationships may be the most efficient technique for the specified effectiveness level.

The data in Table 17 also reveal a higher degree of dispersion in the error rates when the analytic tests are applied at a point-in-time than when applied on a monthly basis. This implies that analytical review procedures applied on a monthly basis will provide greater consistency in the reliability of the analytic tests. The use of monthly cutoff tests are also beneficial in that such tests may be conducted at any time after the end of the month. The auditor may conduct portions of the audit throughout the year, and is not limited to evaluations after September and December (assuming a twelve month audit period with year end in December). This could reduce scheduling and allocation problems currently encountered in the October to March time period.

Another issue concerning the cutoff for analytic tests is whether September and December point-in-time tests yield comparable levels of reliability. Table 17 shows that the largest difference between analytic tests applied at the two points-in-time, in terms of both efficiency and effectiveness, is less than 0.055. This difference is not considered significant. Hence, it is concluded that analytic tests applied at both interim and end-of-period cutoff points provide comparable levels of efficiency and

effectiveness.

In summary, monthly cutoff tests appear more consistent with respect to reliability than point-in-time cutoff tests.

Additionally, analytic tests which incorporate statistical and materiality-based decision rules provide greater confidence that maximum AR is met.

#### Firm and Time Period Effects

Table 18 presents the average error rates and associated standard deviations for the analytic tests across the two firms and two time periods per firm. Although the same time periods are evaluated for each firm, the financial data within each period is unique to the firm. Hence, the time-periods are considered subsamples of the firm.

The Friedman test applied to the data presented in Table 18 produces test statistics of 33.6 and 30.5 for the type I and type II error rates, respectively. The test statistics are asymptotically distributed as a Chi-square distribution with three degrees of freedom. Comparison of the test statistics with the corresponding Chi-square value of 9.348 indicates that the firm effect is statistically significant.

The differences between the firm and time period effects were analyzed using the multiple comparison procedure. The results are summarized in Table 19. The information in Table 19 indicates that there is a statistically significant difference between the error rates across firms. This result was expected. During the personal interviews, all of the participants indicated that each manufacturing firm is unique in some respect, and that it is very difficult to generalize within the manufacturing industry.

The impact of the firm effect is that the confidence



TABLE 18 - Continued.

Analytic Tests	Firm A - 1980		Firm A - 1981		Firm B - 1980		Firm B - 1981	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
Individual Accounts - Type I Errors								
Monthly Cutoff Tests								
Material Change . . . .	.767	.200	.719	.272	.647	.234	.612	.221
Yearly Change . . . .	.804	.310	.573	.314	.419	.284	.406	.318
Monthly Change . . . .	.349	.227	.324	.254	.167	.250	.151	.206
Time Series . . . .	.839	.258	.608	.269	.683	.367	.670	.343
September Point-In-Time								
Material Change . . . .	.934	.245	.780	.410	.810	.392	.740	.437
Yearly Change . . . .	.824	.381	.492	.498	.290	.454	.581	.494
December Point-In-Time								
Material Change . . . .	.870	.334	.813	.388	.634	.482	.710	.454
Yearly Change . . . .	.654	.474	.562	.496	.100	.310	.677	.468
Individual Accounts - Type II Errors								
Monthly Cutoff Tests								
Material Change . . . .	.165	.239	.104	.218	.244	.296	.265	.299
Yearly Change . . . .	.201	.314	.413	.316	.586	.303	.507	.329
Monthly Change . . . .	.623	.249	.646	.277	.814	.295	.834	.243
Time Series . . . .	.069	.173	.099	.184	.161	.265	.197	.300
September Point-In-Time								
Material Change . . . .	.079	.266	.102	.377	.166	.368	.240	.424
Yearly Change . . . .	.176	.381	.466	.493	.709	.454	.420	.494
December Point-In-Time								
Material Change . . . .	.124	.322	.177	.376	.372	.482	.257	.436
Yearly Change . . . .	.332	.467	.426	.492	.871	.336	.330	.469

TABLE 19  
 COMPARISONS OF THE EFFECTS OF FIRMS AND TIME  
 PERIODS ON THE AVERAGED ERROR RATES

Type I Error Rates

	Firm A - 1981	Firm B - 1980	Firm B - 1981
Firm A - 1980 . .	Similiar	Different	Different
Firm A - 1981 . .	---	Different	Different
Firm B - 1980 . .	---	---	Similiar

Type II Error Rates

	Firm A - 1981	Firm B - 1980	Firm B - 1981
Firm A - 1980 . .	Similiar	Different	Different
Firm A - 1981 . .	---	Different	Different
Firm B - 1980 . .	---	---	Similiar

associated with a specific analytic test meeting maximum AR will vary as different firms are analyzed. The size of the variation due to the firm effect makes it inappropriate to suggest that analytic tests applied to other firms will meet maximum AR at the confidence levels derived in this study. This suggests that standardized audit programs which apply the same techniques to different firms should be used with caution.

Another finding of this analysis is that the relative performance of the analytic tests across the firms in this study is concordant. This suggests that certain analytic tests are consistently more reliable across firms than other analytic tests. Hence, a minimal set of analytical review procedures could be developed which should provide the best evidence available from analytical review, even when applied to different firms. However, the best evidence available from analytical review may not provide sufficient audit assurance. The effects of applying the analytic tests to financial data from additional firms must be analyzed before any general conclusions are appropriate.

Within a firm, the time period for the financial data set does not produce a significant change in the type I and type II error rates. This result is not unexpected since the time periods are consecutive. If a greater separation in time periods was available, then these results might allow a generalization that the analytical procedures are consistent across various time periods. However, the only conclusion that can be derived from this data is that, for these two firms, the analytical procedures performed consistently from one audit period to the next audit period. This supports the audit practice of using the prior period's audit program as a reference point for audit planning.

Table 20 provides an indication of the relative variation in

TABLE 20  
RELATIVE VARIATION OF AVERAGED ERROR RATES WITHIN EACH TREATMENT

Analytic Tests	Firm		Error Size		Error Distribution		Financial Relationship	
	Type I	Type II	Type I	Type II	Type I	Type II	Type I	Type II
Financial Ratios								
Monthly Cutoff Tests								
Numerator Benchmark . . .	.0887	.5452	.1045	.0190	.0637	.6450	.0933	1.7197
Denominator Benchmark . . .	.1083	.7058	.0660	.0285	.0451	.5448	.0750	2.0141
10% Percent Change . . .	.1663	.2557	.0068	.0036	.0003	.0304	1.1237	1.3653
Regression . . .	.1647	.4326	.3001	.0330	.1744	.9264	1.0235	1.4022
September Point-In-Time								
Numerator Benchmark . . .	.0854	.3056	.0049	.0376	.0032	.0270	1.1372	2.0039
Denominator Benchmark . . .	.0615	.3219	.0054	.0070	.0027	.0719	1.0326	2.2509
10% Percent Change . . .	.1302	.1550	.0042	.0051	.0025	.0062	1.2987	1.3640
December Point-In-Time								
Numerator Benchmark . . .	.1350	.5264	.0003	.0226	.0004	.0051	1.1012	2.6297
Denominator Benchmark . . .	.1309	.6649	.0079	.0099	.0033	.0355	1.0757	2.0946
10% Percent Change . . .	.2356	.3448	.0311	.0333	.0017	.0073	1.2350	1.4637
Individual Accounts								
Monthly Cutoff Tests								
Numerator Benchmark . . .	.1019	.2218	.1904	.0416	.1160	.4948	1.1937	1.5457
Denominator Benchmark . . .	.3354	.4091	.0017	.0083	.0061	.0109	1.3012	1.4792
10% Percent Change . . .	.4161	.3511	.0360	.0136	.0420	.0368	1.4087	1.1470
Regression . . .	.1146	.4427	.0015	.0091	.1114	.0909	1.1300	1.5566
September Point-In-Time								
Numerator Benchmark . . .	.1027	.4003	.0104	.0419	.0021	.0300	1.1660	3.0565
Denominator Benchmark . . .	.4094	.4920	.0101	.0142	.0079	.0164	1.4016	1.6141
10% Percent Change . . .	.1300	.4050	.0098	.0457	.0066	.0166	1.1506	2.0357
Regression . . .	.5338	.5974	.0098	.0108	.0037	.0089	1.2929	1.5998

the error rates associated with the analytic tests within the various treatments. The relative variation is measured by the coefficient of variation, which divides the standard deviation of the error rates across a treatment by the averaged error rate for the treatment. Since the coefficients of variation are presented in standardized units for each treatment, they may be used to assess the relative significance of the effects from various treatments. A smaller coefficient of variation associated with an analytic tests for a specified treatment indicates that the amount of variation in the error rates of the analytic test across the levels of the specified treatment are also smaller. This implies that the specified treatment has a lesser influence on the error rates of the analytic test than treatments which are associated with larger coefficients of variation. Within this study, the relative order of the treatments with respect to the greatest amount of influence on the error rates of the analytic tests are: financial relationship, firm, error distribution and error size.

With respect to the firm treatment, the variation in the effectiveness of the analytic tests appears to be more pronounced than the variation in the efficiency. Analytic tests which incorporate traditional decision rules have the largest relative variation in efficiency resulting from the change in firms. Analytic tests which incorporate materiality-based decision rules have less relative variation in efficiency across firms, except for the material change test applied to individual accounts at the end-of-period (December point-in-time).

In summary, there is a significant difference in the reliability of analytic tests applied to different firms. Additionally, the effect of the firm treatment is significant in

relation to the effect of other treatments, and is considered as having an important influence on the reliability of analytical review procedures. There does not appear to be any significant differences between the reliability of analytic procedures applied to two consecutive time periods.

#### Size of monetary error

In the simulation process, error size is expressed in multiples of a material amount. The materiality-based error sizes represent the total amount of monetary error directly seeded into the financial accounts. For type I error rates, the treatment levels are no error and 0.5 and 0.8 times a material amount. For type II error rates, the treatment levels are 1.0, 1.5 and 2.0 times a material amount.

The average error rates and associated standard deviations are presented in Table 21. Application of the Friedman test to this data produces test statistics of 19.8 and 17.4 for the type I and type II error rates, respectively. These test statistics indicate that the treatment levels produce statistically different error rates.

As the size of the monetary error seeded into the financial data increases, the number of investigations signalled by the analytic tests should also increase. This would produce an increasing type I error rate and a decreasing type II error rate. In general, these trends are evident from the data presented in Table 21.

However, visual inspection of the data presented in Table 21 reveals a smaller change than expected in the number of investigations signalled as the size of the monetary error increases. For example, the type II error rate for the numerator



benchmark test applied on a monthly basis (first row of table 21) only changes four percent as the size of the monetary error is increased from a material amount to two times a material amount. Further analysis revealed an interaction effect between the size of the monetary error and the financial relationships. In other words, for some financial relationships the number of investigations signalled by the analytic test do not increase as the size of the seeded monetary error increases. There may be increasing trends, decreasing trends, no change or inconsistent behavior in the data for each analytic test as it is applied to different financial relationships.

Inconsistent behavior is demonstrated in Figure 7. The error-free financial data (indicated by a "\*") is typical of seasonal variations where decreased operational activity occurs in the November to February time frame. This situation could exist for construction and mining firms. Above each error-free monthly balance, the balances after seeding 0.5, 1.0, 1.5 and 2.0 times a material amount are depicted. The solid line represents the predicted values for each month and the dotted lines define the precision interval.

For the different error sizes, the number of investigations signalled are:

- a. no error - six
- b. 0.5 times materiality - eight
- c. 1.0 times materiality - nine
- d. 1.5 times materiality - nine
- e. 2.0 times materiality - eight.

For the situation depicted in Figure 7, the number of investigations signalled by the analytic test first increases and then decreases as the size of the monetary error increases. This

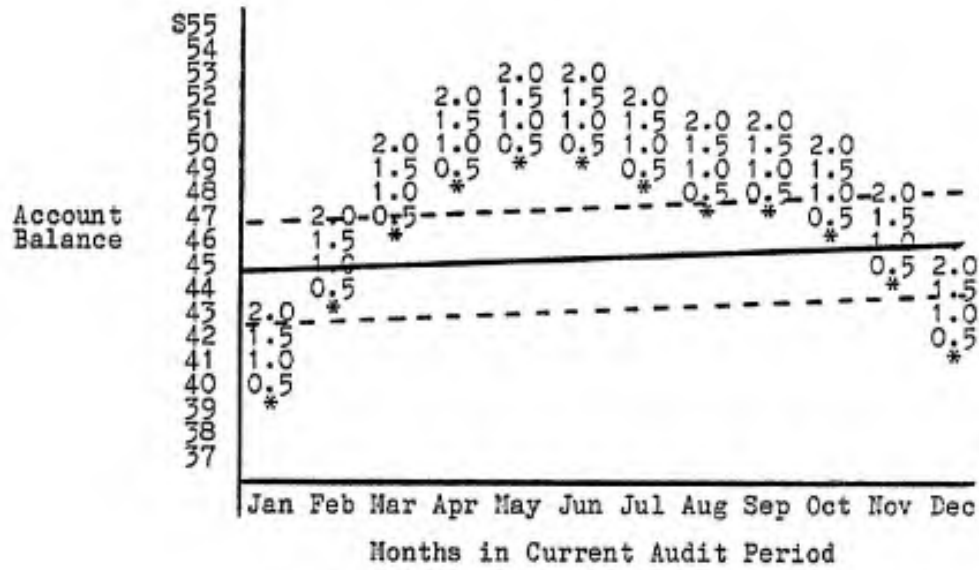


Fig. 7. Demonstration of inconsistent behavior in the number of investigations signalled as monetary error increases from zero to two times a material amount.

overall pattern is defined in this study as inconsistent behavior.

Increasing trends result when the difference between the true value and the predicted value are less than the precision of the analytic test. In Figure 7, evaluations of the monthly balances in February, March, August, September, October and November result in increasing trends in the number of investigations signalled.

Decreasing trends result under the following two conditions: (a) the true value is less than the predicted value by an amount greater than the precision of the analytic test when overstatement errors occur, and (b) the true value is greater than the predicted value by an amount greater than the precision of the analytic test when understatement errors occur. This decreasing trend in the number of investigations signalled occurs during evaluations of the monthly balances in January and December of Figure 7.

For no change to occur in the number of investigations signalled, the range of the monetary error from the true value to the true value plus two times a material amount must be outside of the precision interval for the analytic test. This occurs during evaluations of the monthly balances of April, May, June and July of Figure 7.

Since the data in Table 21 are aggregated across financial relationships, the decreasing trends and inconsistent behavior reduce the total number of investigations signalled. The data in Table 21 was disaggregated by financial relationship, and categorized as having an increasing trend or non-increasing trend as the size of the monetary error seeded into a single month increases. Limiting the analysis to error seeded into a single month eliminates some confounding effects caused by the distribution of the monetary error. These distribution effects are discussed in a later section.

The results of the disaggregated analysis are presented in Table 22. For each level of the error size treatment, Table 22 shows the percentage of monthly balances evaluated by the analytic test in which investigations are signalled. Non-increasing investigations represent those situations where the number of signalled investigations do not consistently increase as the size of the monetary error increases. For sixteen of the eighteen analytic tests, the total change in the percentage of signalled investigations is less than two. The other two analytic tests have changes of less than five percent.

In contrast, the smallest percentage change for those situations where the number of investigations signalled consistently increase as the size of the monetary error increases from zero to twice materiality was nine percent. On average, financial ratios increased 17 percent when evaluated on a monthly basis and 51 percent when evaluated at a point in time. Individual accounts averaged a 28 percent increase when evaluated on a monthly basis and a 30 percent increase when evaluated at a point in time.

Comparisons of the effects between the error sizes on the number of investigations signalled are presented in Table 23. These results suggest that for situations of non-increasing trends, there is some difference between no error and some error, but no statistical differences between different amounts of monetary error. For situations with increasing trends, there is a statistically significant increase in the number of investigations signalled as the size of the monetary error increases.

These results indicate that the analytic tests evaluated in this study are sensitive to the size of the monetary error when the differences between the true and predicted values are less than the

TABLE 22  
EFFECT OF ERROR SIZE ON THE NUMBER OF INVESTIGATIONS SIGNALLED

Analytic Tests	Percentage of Monthly Balances Evaluated in which Investigations are Signaled					
	No Error	0.5 x Materiality	0.8 x Materiality	1.0 x Materiality	1.5 x Materiality	2.0 x Materiality
Non-Increasing Investigations Across Financial Ratios						
Monthly Cutoff Tests						
Numerator Benchmark	.7645	.7569	.7569	.7596	.7583	.7549
Denominator Benchmark	.7041	.7287	.7117	.7187	.7857	.7871
10% Percent Change	.6510	.6391	.6322	.6399	.6362	.6302
Regression	.4192	.3939	.3906	.3948	.3990	.4002
September Point-In-Time						
Numerator Benchmark	.8005	.8030	.8073	.8067	.8079	.8067
Denominator Benchmark	.8509	.8328	.8317	.8272	.8326	.8333
10% Percent Change	.5533	.5478	.5478	.5433	.5433	.5378
December Point-In-Time						
Numerator Benchmark	.8311	.8311	.8311	.8311	.8311	.8311
Denominator Benchmark	.8621	.8646	.8246	.8546	.8546	.8546
10% Percent Change	.6084	.6084	.6020	.5956	.5816	.5600
Non-Increasing Investigations Across Individual Accounts						
Monthly Cutoff Tests						
Material Change	.5543	.5408	.5326	.5399	.5399	.5480
Yearly Change	.5833	.5716	.5617	.5630	.5630	.5543
Monthly Change	.2303	.2242	.2205	.2235	.2276	.2280
Time Series	.6420	.6073	.6034	.6080	.6212	.6481
September Point-In-Time						
Material Change	.8993	.8937	.8937	.8954	.8949	.8999
Yearly Change	.6039	.6039	.6039	.6039	.6039	.6093
December Point-In-Time						
Material Change	.8601	.8520	.8520	.8537	.8526	.8444
Yearly Change	.5306	.5306	.5232	.5232	.5232	.5164

TABLE 22 - Continued.

Analytic Tests	Percentage of Monthly Balances Evaluated in which Investigations are Signalled					
	No Error	0.5 x Materiality	0.8 x Materiality	1.0 x Materiality	1.5 x Materiality	2.0 x Materiality
Increasing Investigations Across Financial Ratios						
Monthly Cutoff Tests						
Numerator Benchmark	.6237	.6747	.7177	.7392	.8145	.8306
Denominator Benchmark	.8207	.8838	.8939	.8990	.9062	.9091
10% Percent Change	.5417	.7826	.6063	.6083	.6292	.6625
Regression	.5126	.6085	.6431	.6903	.7547	.7940
September Point-In-Time						
Numerator Benchmark	.0000	.0909	.0909	.0909	.2424	.3409
Denominator Benchmark	.0000	.0000	.2222	.2222	.2500	.4722
10% Percent Change	.0000	.0000	.0000	.0000	.3533	.6667
December Point-In-Time						
Numerator Benchmark	.0000	.0000	.0625	.0625	.3125	.3125
Denominator Benchmark	.0000	.4762	.4762	.4762	.4762	.4762
10% Percent Change	.0000	.4444	.6759	.6759	.6952	.7963
Increasing Investigations Across Individual Accounts						
Monthly Cutoff Tests						
Material Change	.5185	.6042	.6905	.6771	.7465	.8044
Yearly Change	.5862	.6695	.6697	.7069	.7557	.7701
Monthly Change	.3148	.4321	.5123	.5293	.5802	.6250
Time Series	.4881	.6101	.6696	.7128	.6006	.8289
September Point-In-Time						
Material Change	.0000	.1389	.2667	.2667	.3278	.3333
Yearly Change	.0000	.1000	.1000	.1000	.2600	.2083
December Point-In-Time						
Material Change	.1905	.2500	.2540	.2540	.2135	.4762
Yearly Change	.3529	.5332	.5980	.5980	.5980	.7255

TABLE 23  
COMPARISON OF THE EFFECTS OF ERROR  
SIZE ON INVESTIGATIONS SIGNALLED

Non-Increasing Trend in the Number of Investigations Signalled					
	0.5 x Materiality	0.8 x Materiality	1.0 x Materiality	1.5 x Materiality	2.0 x Materiality
No Error . . .					
0.5 x Materiality . . .	Different	Different	Different	Different	Different
0.8 x Materiality . . .	---	Similar	Similar	Similar	Similar
1.0 x Materiality . . .	---	---	---	---	Similar
1.5 x Materiality . . .	---	---	---	---	Similar

Increasing Trend in the Number of Investigations Signalled					
	0.5 x Materiality	0.8 x Materiality	1.0 x Materiality	1.5 x Materiality	2.0 x Materiality
No Error . . .					
0.5 x Materiality . . .	Similar	Different	Different	Different	Different
0.8 x Materiality . . .	---	Similar	Similar	Similar	Similar
1.0 x Materiality . . .	---	---	---	---	Different
1.5 x Materiality . . .	---	---	---	---	Similar

precision of the analytic test. When the difference equals or exceeds the precision of the analytic test, two conditions can result.

a. If the difference between the true value plus the amounts of error and the predicted value always equal or exceed the precision of the analytic test, investigations are always signalled. Hence, there is no sensitivity to the size of the monetary error.

b. Otherwise, there is a sensitivity to the size of the monetary error, but in the opposite direction than expected. Increased error size produces decreasing type I error rates and increasing type II error rates.

Analysis of the relative variation within the type I and type II error rates resulting from the error size treatments is obtained from Table 20, which was presented earlier. The greatest influence occurs in the efficiency of the analytic tests which incorporate statistical decision rules (regression and time series). The error size treatment also affects the efficiency of analytic tests which incorporate materiality-based decision rules and are applied on a monthly basis (numerator benchmark, denominator benchmark and material change).

Visual analysis of the overall effects of the error size treatment on the efficiency and effectiveness of the analytic tests do not appear to be significant when compared to the effects of other treatments. The implication of these results is that the size of the monetary error in the financial account is not a major influence on the overall type I and type II error rates. The decision rules appear to signal investigations as a result of normal fluctuations in the balances of the financial accounts, prior to the introduction of material monetary errors.

In this study, the differences between the true balances and the predicted balances of the monthly financial accounts were found to exceed the precision of the analytic test in: (a) 74 percent of the months evaluated by applying analytic tests to financial ratios on a monthly basis, (b) 96 percent of the months evaluated by applying analytic tests to financial ratios at a point-in-time, (c) 68 percent of the months evaluated by analytic tests applied to individual accounts on a monthly basis, and (d) 90 percent of the months evaluated by analytic tests applied to individual accounts at a point-in-time. These values indicate that point-in-time tests should have a greater tendency to signal investigations than the monthly cutoff tests. Although the analytic tests are sensitive to the size of the monetary error, other factors appear to be the major determinant of the overall reliability.

#### Error direction

The results of the absolute error size analysis cannot distinguish whether the direction of the seeded error has a significant impact. This question can only be answered by limiting the analysis to pairs of financial relationships where equal sized errors were seeded in both directions. Thus, a separate analysis was conducted on the effect of the direction of the seeded error on the type I and type II error rates associated with analytic tests.

The direction treatment has two levels, understatement and overstatement. Financial relationships in which two of the replications are identical except for the direction of the errors compose the direction treatment levels. The observations within the model represent measurement against conditions where some error

was seeded into the financial data. Since analysis of the direction of error implies that some error was seeded, the no error condition was not included in the type I models. Thus, in type I models, the observations represent 0.5 and 0.8 materiality-based error size conditions. For type II models, observations are based on error conditions of 1.0, 1.5 and 2.0 times a material amount. Since earlier analysis indicates that error rates are not expected to vary significantly across the materiality-based error sizes, aggregation across the error sizes should not introduce large biases into the averages across the direction of the error.

The averaged error rates and associated standard deviations for the effect of error direction on the analytic test are presented in Table 24. Application of the Wilcoxon test to this data produces test statistics of 28 for 16 observations of type I error rates and 37 for 18 observations of type II error rates. The type I error rates for the numerator benchmark and 10 percent change analytic tests applied at a December point-in-time were equal, and thus must be excluded from the Wilcoxon test.

The test statistics indicate a significant difference between overstatement and understatement errors for the type I and type II error rates associated with analytic tests. Visual inspection of the information in Table 24 indicates a trend in the efficiency of analytic tests applied on a monthly basis to financial ratios. Understatement errors are associated with higher type I error rates and lower type II error rates. This trend can be explained by the nature of analytical procedures applied to financial ratios.

Analytic tests applied to financial ratios assume consistent growth in all financial accounts. When this assumption is not met, the procedures become more sensitive to overstatement or understatement errors. This situation is demonstrated in Table 25.

TABLE 24  
EFFECT OF ERROR DIRECTION ON THE AVERAGED ERROR RATES OF ANALYTIC TESTS

Analytical Procedure	Understatement				Overstatement			
	Type I Error		Type II Error		Type I Error		Type II Error	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
Financial Ratios								
Monthly Cutoff Tests								
Numerator Benchmark . . . . .	.770	.318	.141	.247	.760	.327	.172	.265
Denominator Benchmark . . . . .	.655	.269	.100	.237	.846	.274	.122	.247
10% Percent Change . . . . .	.630	.371	.371	.367	.616	.379	.401	.385
Regression . . . . .	.654	.377	.205	.317	.649	.374	.221	.320
September Point-In-Time								
Numerator Benchmark . . . . .	.616	.484	.354	.470	.600	.490	.395	.488
Denominator Benchmark . . . . .	.833	.373	.166	.371	.832	.373	.197	.392
10% Percent Change . . . . .	.533	.499	.467	.499	.521	.498	.500	.498
December Point-In-Time								
Numerator Benchmark . . . . .	.700	.458	.276	.446	.700	.458	.298	.457
Denominator Benchmark . . . . .	.855	.371	.156	.358	.823	.378	.172	.371
10% Percent Change . . . . .	.567	.496	.433	.496	.567	.496	.444	.497
Individual Accounts								
Monthly Cutoff Tests								
Material Change . . . . .	.725	.290	.198	.265	.724	.288	.195	.263
Yearly Change . . . . .	.628	.316	.379	.321	.627	.320	.367	.328
Monthly Change . . . . .	.250	.252	.734	.264	.246	.241	.742	.258
Time Series . . . . .	.786	.296	.127	.245	.784	.295	.122	.241
September Point-In-Time								
Material Change . . . . .	.834	.372	.163	.366	.833	.373	.166	.371
Yearly Change . . . . .	.595	.491	.400	.489	.601	.489	.395	.488
December Point-In-Time								
Material Change . . . . .	.809	.393	.194	.393	.819	.383	.173	.371
Yearly Change . . . . .	.587	.493	.405	.491	.596	.489	.388	.480

TABLE 25  
SENSITIVITY OF ANALYTICAL PROCEDURES TO VARYING CONDITIONS OF ECONOMIC GROWTH

	Previous Year	Current Year Constant Growth	Current Year Lower Costs	Current Year Higher Costs
Financial Accounts				
Sales	\$1,000	\$1,150	\$1,150	\$1,150
Cost of Sales	500	575	545	605
Gross Margin	500	575	605	545
Administrative Expense	300	345	345	345
Net Income	200	230	260	200
Gross Margin Percentage	0.5	0.5	0.526	0.474
Precision Intervals				
Numerator Benchmark	--	+50 -- -50	+20 -- -80	+80 -- -20
Denominator Bench.	--	+100 -- -100	+40 -- -160	+160 -- -40
10% Change	--	+0.050 -- -0.050	+0.024 -- -0.076	+0.076 -- -0.024
Regression	--	+50 -- -50	+20 -- -80	+80 -- -20

Gross margin percentage is evaluated under different economic growth patterns. The first column presents hypothetical income statement data for a previous audit year. The second column presents the current year balances under the assumption of consistent 15 percent growth in all accounts. The third and fourth columns assume a consistent 15 percent growth in all accounts except cost of sales. The third column assumes increased efficiency, resulting in lower costs, while the fourth column assumes higher costs.

Under the economic conditions reflected in the third column, all of the analytic tests evaluated in this study become more sensitive to overstatement errors, and less sensitive to understatement errors. Assume that the account materiality thresholds are \$100 for sales and \$50 for gross margin. The numerator benchmark test has a designed precision interval of plus or minus \$50. However, under the true economic conditions reflected in column three, the actual precision interval is plus \$20 to minus \$80. The economic conditions reflected in column four produce an actual precision interval of plus \$80 to minus \$20, indicating an increased sensitivity to understatement errors.

The economic conditions reflected within the financial data analyzed in this study are similar to the situation presented in column four. Operating costs appear to be increasing at a faster rate than revenues. Thus, it is expected that the analytic tests evaluated within this study have decreased sensitivity to overstatement errors and increased sensitivity to understatement errors. It is more likely that the procedures will signal an investigation for understatement errors than for overstatement errors. This appears to be the trend that is reflected in Table 24.

The major implication of the error direction analysis results from the varying sensitivity of the analytical review procedures to overstatement and understatement errors under varying economic conditions. A potentially hazardous situation exists in periods where costs increase at a faster rate than revenues. If management is at all inclined to manipulate the financial statements, this economic situation offers the most incentive to overstate revenues or understate costs. The analytical review procedures evaluated in this study would be more sensitive to the understated costs, but less sensitive to overstated revenues. Hence, the procedures are less likely to detect overstatements when there is a higher incentive to overstate revenue accounts.

This suggests that auditors should incorporate economic trends in their analytical review procedures. When structural models are used, additional independent variables can be included which allow introduction of economic trend data. For traditional methods, the auditor must either adjust the generated expectations for the economic trends or adjust the precision intervals to compensate for the general economic conditions. Non-symmetric precision intervals may be developed which reflect general economic conditions for prespecified risk levels. Further research should be directed at determining the best method for incorporating economic trends into analytical procedures.

#### Distribution of the monetary error

The error rates and associated standard deviations for the analytic tests applied across the various distributions of monetary error are presented in Table 26. The Friedman test applied to this data produces test statistics of 102.3 for both type I and type II error rates. This test statistic indicates that the difference in

TABLE 26

EFFECT OF ERROR DISTRIBUTION ON THE AVERAGED ERROR RATES OF ANALYTIC TESTS

Analytic Tests	Single Month		2 Random Months		3 Random Months		4 Random Months		End of Period		Evenly Distributed	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
Financial Ratios - Type I Errors												
Monthly Cutoff Tests	.742	.335	.613	.287	.644	.257	.663	.246	.669	.249	.690	.234
Numerator Benchmark	.600	.290	.617	.265	.666	.246	.682	.224	.686	.226	.913	.192
Denominator Benchmark	.625	.365	.617	.385	.626	.374	.628	.374	.632	.384	.626	.366
10% Percent Change	.466	.345	.649	.357	.726	.332	.761	.318	.750	.322	.795	.325
Regression												
September Point-In-Time	.753	.429	.752	.431	.754	.429	.753	.430	.759	.428	.757	.431
Numerator Benchmark	.619	.362	.619	.382	.619	.384	.619	.383	.614	.390	.618	.386
Denominator Benchmark	.542	.498	.543	.498	.542	.498	.546	.493	.544	.499	.544	.499
10% Percent Change												
December Point-In-Time	.810	.392	.609	.393	.609	.393	.609	.393	.609	.393	.609	.393
Numerator Benchmark	.832	.372	.635	.368	.630	.376	.630	.375	.627	.379	.627	.379
Denominator Benchmark	.592	.491	.594	.491	.592	.492	.594	.491	.594	.492	.592	.492
10% Percent Change												
Financial Ratios - Type II Errors												
Monthly Cutoff Tests	.235	.322	.145	.258	.105	.190	.077	.146	.070	.157	.033	.077
Numerator Benchmark	.190	.295	.127	.253	.100	.217	.079	.100	.073	.178	.030	.072
Denominator Benchmark	.365	.359	.397	.395	.383	.390	.369	.371	.373	.393	.375	.367
10% Percent Change	.479	.367	.228	.311	.136	.223	.084	.152	.095	.173	.031	.092
Regression												
September Point-In-Time	.235	.417	.237	.419	.238	.419	.238	.421	.224	.417	.226	.419
Numerator Benchmark	.179	.376	.184	.384	.187	.385	.187	.387	.191	.393	.189	.392
Denominator Benchmark	.461	.494	.464	.497	.462	.497	.463	.496	.469	.500	.463	.499
10% Percent Change												
December Point-In-Time	.185	.367	.184	.386	.186	.389	.186	.390	.185	.390	.186	.390
Numerator Benchmark	.163	.366	.161	.362	.160	.361	.159	.363	.154	.361	.171	.377
Denominator Benchmark	.413	.491	.412	.491	.411	.492	.412	.491	.406	.492	.414	.493
10% Percent Change												

TABLE 26 - Continued.

Analytic Tests	Single Month		2 Random Months		3 Random Months		4 Random Months		End of Period		Evenly Distributed	
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.

Individual Accounts - Type I Errors

Monthly Cutoff Tests												
Material Change . . . . .	.564	.288	.652	.306	.713	.290	.736	.289	.735	.311	.800	.274
Yearly Change . . . . .	.586	.343	.581	.361	.584	.353	.590	.343	.581	.347	.506	.339
Monthly Change . . . . .	.209	.258	.261	.263	.260	.249	.264	.249	.276	.258	.264	.234
Time Series . . . . .	.608	.333	.743	.311	.791	.290	.810	.289	.807	.297	.849	.280
September Point-In-Time												
Material Change . . . . .	.826	.373	.825	.375	.825	.378	.825	.376	.829	.377	.825	.380
Yearly Change . . . . .	.571	.494	.570	.495	.570	.495	.572	.494	.579	.494	.579	.494
December Point-In-Time												
Material Change . . . . .	.775	.416	.778	.413	.776	.416	.778	.415	.780	.414	.778	.416
Yearly Change . . . . .	.525	.498	.528	.498	.525	.499	.527	.499	.528	.503	.526	.500

Individual Accounts - Type II Errors

Monthly Cutoff Tests												
Material Change . . . . .	.370	.281	.264	.277	.192	.242	.167	.225	.165	.265	.072	.138
Yearly Change . . . . .	.407	.350	.413	.379	.409	.355	.419	.344	.417	.352	.412	.339
Monthly Change . . . . .	.658	.307	.723	.316	.701	.277	.720	.258	.704	.279	.730	.240
Time Series . . . . .	.321	.314	.148	.244	.093	.178	.073	.169	.066	.177	.020	.093
September Point-In-Time												
Material Change . . . . .	.157	.350	.160	.359	.161	.362	.164	.367	.152	.360	.152	.360
Yearly Change . . . . .	.417	.487	.417	.492	.417	.492	.419	.492	.402	.491	.407	.492
December Point-In-Time												
Material Change . . . . .	.214	.403	.216	.406	.211	.404	.215	.407	.209	.407	.207	.406
Yearly Change . . . . .	.467	.496	.466	.495	.463	.496	.463	.496	.455	.499	.461	.499

the treatment levels is significant.

Multiple comparisons applied to this data to identify the differences are summarized in Table 27. These results suggest a significant trend across the distribution levels. Visual analysis of the data in Table 26 indicates that error rates for the monthly statistical and materiality-based decision rules change consistently across the monthly distribution of the error. As the number of months in which the error is distributed increases, the type I error rate increases and the type II error rate decreases. The trend is statistically significant.

This result contradicts what is expected. A material monetary error seeded into a single month should be easier to detect, thereby producing the lowest number of type II errors rather than the highest. However, if the decision to investigate is based on normal fluctuations in the data and is not dependent on the error size, then spreading the error into more months would mean that more correct decisions to investigate are made, resulting in a reduced type II error rate.

Recall that the statistical and materiality-based decision rules adjust the comparison criterion for the number of months in which the monetary errors are expected to occur. The comparison criterion is set equal to the materiality threshold for the financial account,  $M_0$ , when the error is seeded into one month. Seeding the error into two months reduces the comparison criterion by one-half, to  $M_0/2$ .

This situation is reflected in Figures 8 and 9. Figure 8 represent a search for monetary errors distributed in one month while Figure 9 represents a search for monetary error distributed in two months. In both Figures 8 and 9, the financial data represents a cyclic fluctuation across time. Error free financial

TABLE 27  
 COMPARISON OF THE EFFECTS OF DISTRIBUTION  
 ON THE AVERAGED ERROR RATES

Type I Error Rates

	2 Random Months	3 Random Months	4 Random Months	End of Period	Evenly Distrib.
Single Month . . .	Similar	Similar	Similar	Different	Different
2 Random Months . . .	---	Similar	Different	Different	Different
3 Random Months . . .	---	---	Different	Different	Different
4 Random Months . . .	---	---	---	Similar	Different
End of Period . . .	---	---	---	---	Similar

Type II Error Rates

	2 Random Months	3 Random Months	4 Random Months	End of Period	Evenly Distrib.
Single Month . . .	Similar	Similar	Similar	Different	Different
2 Random Months . . .	---	Similar	Different	Different	Different
3 Random Months . . .	---	---	Different	Different	Different
4 Random Months . . .	---	---	---	Similar	Different
End of Period . . .	---	---	---	---	Similar

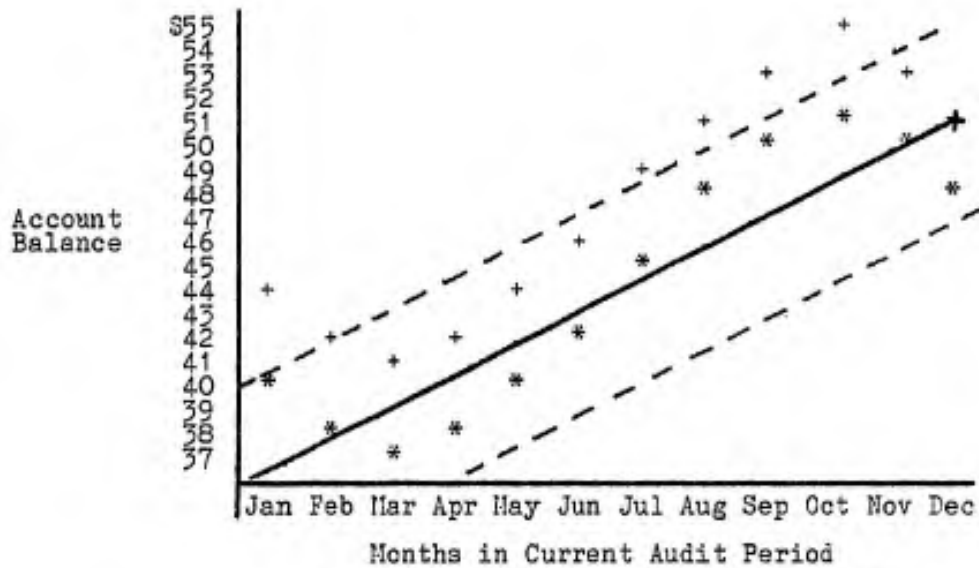


Fig. 8. Investigations signalled when a material error is distributed into a single month.

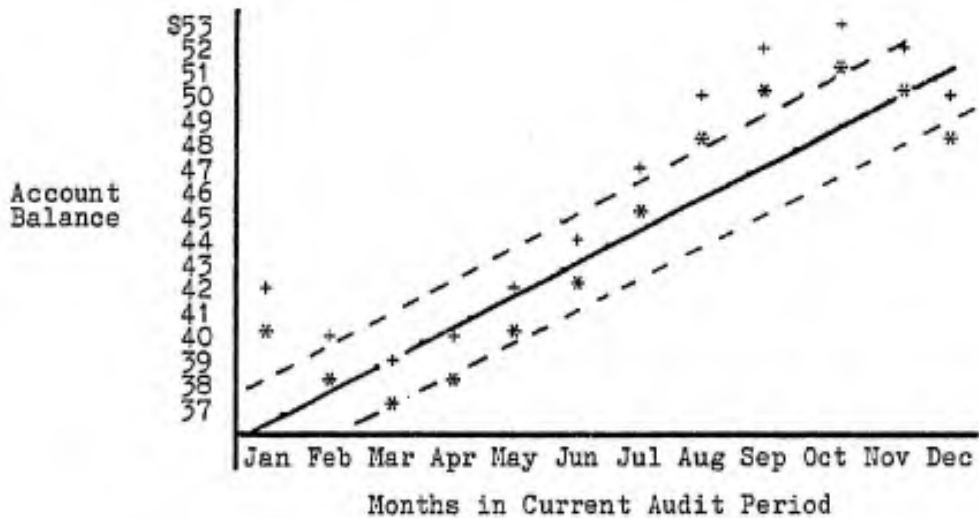


Fig. 9. Investigations signalled when a material error is distributed evenly into two months.

balances are depicted by an "\*", while the "+" indicates that an overstatement error has been seeded into the financial data. The overstatement error equals  $M_0$  in Figure 8 and  $M_0/2$  in Figure 9. The solid line represents the predicted values of the monthly balances while the dashed lines represent the precision interval for the monthly data. The precision is  $M_0$  for Figure 8 and  $M_0/2$  for Figure 9.

If the error free data (\*) in Figure 8 are tested for an error occurring in a single month, no months are signalled for investigation. Five months are signalled for investigation when the seeded data (+) are evaluated. For this situation, the type I error rate is zero and the type II error rate is 58 percent.

In Figure 9, the months are evaluated to determine if an error of one-half a material amount exists in any given month. For the error free data (\*), six months are signalled for investigation, producing a type I error rate of 50 percent. For the seeded data (+), six months are signalled for investigation, producing a type II error rate of 50 percent.

Note that the increase in the number of decisions to investigate is caused by the reduced precision intervals. As the precision interval is condensed, more investigations are signalled due to normal fluctuations. When material errors are not seeded, there is an increase in the number of incorrect decisions to investigate. When material errors are seeded, there is a decrease in the number of incorrect decisions to not investigate. This explains the relationships found in this study for the materiality-based decision rules.

Kinney and Salamon [1981] performed a sensitivity analysis of the DHS decision rule used in the time series and analytic tests. They show that when the error is distributed across a sufficiently

large number of months, the materiality construct (Mo/n) will always exceed the upper precision limit (UPL) and investigations will not be signalled. This suggests that the type II error rate should increase as the error distribution becomes more disperse.<sup>7</sup>

In this study, the materiality construct decreased at a faster rate than the UPL as the number of months evaluated increased from one to five. If the Mo/n initially exceeds the UPL (no investigation signalled), increasing the number of months evaluated from one to five may allow Mo/n to decrease below the UPL, thereby signalling an investigation.

As the number of months evaluated increases beyond five, Mo/n continues to decrease and eventually approaches zero. The UPL also continues to decrease, but now at a faster rate than Mo/n. If Mo/n is greater than UPL at five months, it will remain greater than UPL and an investigation is not signalled. Hence, there is a higher chance that the statistical decision rule will signal an investigation as the number of months evaluated increases from one to five. This pattern is evident in Table 26 for the error rates associated with the regression and time series analytic tests. There is a larger increase in the number of investigations when the error distribution changes from one month to two months than when it changes from two months to three months.

Thus, the distribution of the monetary error does have a significant influence on the statistical and materiality-based decision rules applied on a monthly basis. For both types of decision rules, the number of investigations signalled increases as the error distribution becomes more disperse.

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<sup>7</sup>Kinney and Salamon, "Alternative Investigation Rules," pp. 5-8.

The distribution of the error should not have a significant influence on the monthly traditional decision rules or on the point-in-time analytic tests. Traditional decision rules do not adjust the comparison criterion for the expected distribution of the error. The materiality-based decision rules applied at a point-in-time evaluate cumulative balances. Thus, the rules do not adjust for the expected distribution of the error.

With reference to the relative variation presented in Table 20, the distribution of the error appears to have the most influence on the effectiveness of the structural decision rules (regression and time series). There is some influence on the materiality-based decision rules applied on a monthly basis, but little influence on analytic tests applied at a point-in-time or that incorporate traditional decision rules. These results corroborate the findings discussed above.

In summary, this analysis suggests that statistical and materiality-based decision rules applied on a monthly basis are more sensitive to the distribution of the error across the monthly data than to the size of the error seeded into the accounts. This implies that such decision rules should not be applied to investigate systematic errors unless systematic errors are expected in the financial balances.

If the auditor suspects systematic errors in the financial balances, analytical review procedures may be applied to control type II risk at an acceptable level. In such situations, materiality is allocated over all the months in the current audit period, which increases the sensitivity of the analytic tests to small systematic errors. However, this allocation also results in a higher type I error rate. Thus, when there is a high risk of

systematic errors the auditor must decide whether to do more analytical review as a result of the higher type I error rate or to apply less analytical review and guard against the systematic errors by performing tests of transactions.

### Financial relationships

The average error rates for the analytic tests applied to different financial relationships are summarized in Table 28. Note that the format of this table is different from previous tables. The analytic tests are arranged across the top of the table and the financial relationships are listed vertically. For each financial relationship, the confidence that the type II error rate associated with the analytic test is less than maximum AR (62.5 percent) is provided.

Visual analysis of Table 28 reveals a large variation in the reliability of analytic tests across financial relationships. This is validated by the information in Table 20. The relative variation of the financial relationship treatment is significantly larger than the relative variation of any other treatment.

Kendall's coefficient of concordance was calculated for the data presented in Table 28. For financial ratios, the test statistic evaluates to 0.3102 and 0.3046 for type I and type II error rates, respectively. The test statistic evaluates to 0.4626 and 0.5209 for the type I and type II error rates of the individual accounts. All test statistics are highly significant, indicating that the null hypothesis of no association should be rejected. Thus, it is concluded that the relative effectiveness and efficiency of the analytic tests across the financial relationships is concordant.

The information in Table 28 were analyzed to identify the

TABLE 28  
EFFECT OF FINANCIAL RELATIONSHIPS ON THE AVERAGED ERROR RATES OF ANALYTIC TESTS

Financial Relationships	Numerator Benchmark		Denominator Benchmark		10 Percent Change		Regression	
	Average	Confidence	Average	Confidence	Average	Confidence	Average	Confidence
Monthly Financial Ratios - Type I Errors								
Sales Misc. / G.S.	.602	---	.941	---	.137	---	.493	---
Sales RMA / G.S.	.948	---	.931	---	.660	---	.873	---
Materials / CoS	.903	---	.932	---	.588	---	.924	---
Labor / CoS	.792	---	.942	---	.205	---	.631	---
Overhead / CoS	.965	---	.965	---	.656	---	.888	---
Expense / Related.	.703	---	.650	---	.352	---	.517	---
Prepaid / Related.	.480	---	.580	---	.941	---	.457	---
Acc. Depr. / Related	.862	---	.919	---	.926	---	.553	---
Bad Debt Exp. / H.S.	.873	---	.957	---	.893	---	.411	---
Gross Margin Perc.	.838	---	.930	---	.412	---	.748	---
Receivables Turn.	.952	---	.665	---	.235	---	.834	---
Finished Goods Turn.	.982	---	.943	---	.882	---	.924	---
Allowance / Rec.	.492	---	.914	---	.780	---	.482	---
Current Ratio	.796	---	.789	---	.484	---	.619	---
Quick Ratio	1.000	---	1.000	---	.658	---	.966	---
Op. Income / H.S.	.997	---	.999	---	.889	---	.807	---
Debt / Equity	.962	---	.954	---	.840	---	.627	---
Monthly Financial Ratios - Type II Errors								
Sales Disc. / G.S.	.204	.989	.042	1.000	.872	.880	.313	.876
Sales RMA / G.S.	.038	1.000	.008	1.000	.343	.873	.050	1.000
Materials / CoS	.056	1.000	.023	1.000	.416	.936	.029	1.000
Labor / CoS	.119	1.000	.043	1.000	.798	.625	.197	.991
Overhead / CoS	.020	1.000	.011	1.000	.162	.998	.050	1.000
Expense / Related.	.252	.943	.267	.899	.648	.600	.344	.858
Prepaid / Related.	.369	.877	.390	.898	.056	1.000	.304	.880
Acc. Depr. / Related	.086	.999	.059	1.000	.131	.994	.345	.827
Bad Debt Exp. / H.S.	.078	1.000	.013	1.000	.080	1.000	.334	.894
Gross Margin Perc.	.075	1.000	.038	1.000	.581	.662	.074	1.000
Receivables Turn.	.034	1.000	.254	.991	.772	.552	.036	1.000
Finished Goods Turn.	.003	1.000	.030	1.000	.114	1.000	.022	1.000
Allowance / Rec.	.334	.910	.070	1.000	.223	.997	.274	.904
Current Ratio	.152	.996	.152	.996	.509	.688	.190	.977
Quick Ratio	.000	1.000	.000	1.000	.353	.916	.018	1.000
Op. Income / H.S.	.005	1.000	.003	1.000	.135	1.000	.060	1.000
Debt / Equity	.032	1.000	.034	1.000	.135	1.000	.173	.989

TABLE 28 - Continued.

Financial Relationships	Material Change		Yearly Change		Monthly Change		Time Series	
	Average	Confidence	Average	Confidence	Average	Confidence	Average	Confidence
Monthly Individual Accounts - Type I Errors								
Net Sales . . . . .	.840	---	.754	---	.000	---	.940	---
Cost of Sales . . . . .	.669	---	.660	---	.090	---	.699	---
Gross Profit . . . . .	.837	---	.721	---	.167	---	.919	---
Direct Materials . . . . .	.899	---	.706	---	.224	---	.947	---
Direct Labor . . . . .	.755	---	.563	---	.553	---	.792	---
Factory Overhead . . . . .	.941	---	1.000	---	.276	---	.960	---
Bad Debt Expense . . . . .	.281	---	.000	---	.307	---	.458	---
Expense Accounts . . . . .	.482	---	.483	---	.282	---	.588	---
Total Admin. Exp. . . . .	.726	---	.245	---	.072	---	.653	---
Receivables . . . . .	.760	---	.592	---	.377	---	.748	---
Inventory . . . . .	.684	---	.602	---	.332	---	.733	---
Prop. Plant & Equip . . . . .	.397	---	.836	---	.000	---	.867	---
Accounts Payable . . . . .	.753	---	.613	---	.351	---	.762	---
Accrued Liabilities . . . . .	.465	---	.000	---	.477	---	.455	---
Working Capital . . . . .	.907	---	.836	---	.500	---	.991	---
Monthly Individual Accounts - Type II Errors								
Net Sales . . . . .	.093	1.000	.230	.997	1.000	.000	.027	1.000
Cost of Sales . . . . .	.080	1.000	.314	.914	.906	.853	.034	1.000
Gross Profit . . . . .	.075	1.000	.298	.965	.832	.653	.016	1.000
Direct Materials . . . . .	.057	1.000	.277	.945	.763	.549	.059	1.000
Direct Labor . . . . .	.099	1.000	.353	.878	.594	.851	.064	1.000
Factory Overhead . . . . .	.052	1.000	.000	1.000	.718	.618	.025	1.000
Bad Debt Expense . . . . .	.310	.969	1.000	.000	.539	.772	.169	.992
Expense Accounts . . . . .	.439	.805	.518	.727	.716	.561	.280	.902
Total Admin. Exp. . . . .	.234	.932	.772	.567	.961	1.000	.132	1.000
Receivables . . . . .	.150	.996	.399	.936	.621	.641	.156	.993
Inventory . . . . .	.216	.978	.396	.866	.613	.711	.123	.999
Prop. Plant & Equip . . . . .	.512	.844	.164	1.000	1.000	.000	.082	1.000
Accounts Payable . . . . .	.152	1.000	.424	.939	.596	.666	.145	.977
Accrued Liabilities . . . . .	.238	.995	1.000	.000	.351	.944	.164	.999
Working Capital . . . . .	.064	1.000	.131	1.000	.525	.918	.003	1.000

TABLE 28 - Continued.

Financial Relationships	Numerator Benchmark		Denominator Benchmark		10 Percent Change	
	Average	Confidence	Average	Confidence	Average	Confidence

September Point-In-Time Financial Ratios - Type I Errors

Sales Disc. / G.S.	.500	---	1.000	---	.000	---
Sales MA / G.S.	.500	---	.971	---	.500	---
Materials / CoS	1.000	---	1.000	---	.500	---
Labor / CoS	.545	---	.946	---	.000	---
Overhead / CoS	1.000	---	1.000	---	1.000	---
Expense / Related.	.750	---	.500	---	.250	---
Prepaid / Related.	.000	---	.500	---	1.000	---
Acc. Depr. / Related	.750	---	1.000	---	.955	---
Bad Debt Exp. / H.S.	1.000	---	1.000	---	1.000	---
Gross Margin Perc.	1.000	---	1.000	---	.250	---
Receivables Turn.	1.000	---	.250	---	.000	---
Finished Goods Turn.	.640	---	.506	---	.500	---
Allowance / Rec.	.000	---	.995	---	.500	---
Current Ratio	1.000	---	1.000	---	.500	---
Quick Ratio	1.000	---	1.000	---	.750	---
Op. Income / N.S.	.961	---	.906	---	.749	---
Debt / Equity	.750	---	.750	---	.750	---

September Point-In-Time Financial Ratios - Type II Errors

Sales Disc. / G.S.	.497	.694	.000	1.000	1.000	.000
Sales MA / G.S.	.498	.692	.054	.999	.500	.691
Materials / CoS	.000	1.000	.000	1.000	.500	.691
Labor / CoS	.955	.608	.067	.999	1.000	.000
Overhead / CoS	.000	1.000	.000	1.000	.012	1.000
Expense / Related.	.250	.875	.500	.691	.750	.500
Prepaid / Related.	1.000	.000	.500	.691	.000	1.000
Acc. Depr. / Related	.184	.933	.080	.936	.115	.980
Bad Debt Exp. / H.S.	.000	1.000	.000	1.000	.000	1.000
Gross Margin Perc.	.001	1.000	.000	1.000	.750	.500
Receivables Turn.	.262	.803	.447	.733	.500	.691
Allowance / Rec.	1.000	.000	.046	1.000	.500	.691
Current Ratio	.000	1.000	.000	1.000	.500	.691
Quick Ratio	.000	1.000	.000	1.000	.308	.836
Op. Income / N.S.	.024	1.000	.003	1.000	.235	.895
Debt / Equity	.244	.882	.244	.882	.250	.875

TABLE 28 - Continued.

Financial Relationships	Numerator Benchmark		Denominator Benchmark		10 Percent Change	
	Average	Confidence	Average	Confidence	Average	Confidence
December Point-In-Time Financial Ratios - Type I Errors						
Sales Disc. / G.S.	.500	---	.505	---	.000	---
Sales R&A / G.S.	1.000	---	1.000	---	.500	---
Materials / CoS	1.000	---	1.000	---	1.000	---
Labor / CoS	1.000	---	1.000	---	.000	---
Overhead / CoS	1.000	---	1.000	---	.500	---
Expense / Related.	1.000	---	.500	---	.250	---
Prepaid / Related.	.000	---	.750	---	1.000	---
Acc. Depr. / Related	.750	---	1.000	---	.750	---
Bud Debt Exp. / H.S.	1.000	---	1.000	---	1.000	---
Gross Margin Perc.	.751	---	.762	---	.500	---
Receivables Turn.	1.000	---	.500	---	.250	---
Finished Goods Turn.	1.000	---	1.000	---	1.000	---
Allowance / Rec.	.000	---	.667	---	.500	---
Current Ratio	.750	---	.667	---	.361	---
Quick Ratio	1.000	---	1.000	---	.723	---
Op. Income / N.S.	1.000	---	1.000	---	.763	---
Debt / Equity	1.000	---	1.000	---	.917	---
December Point-In-Time Financial Ratios - Type II Errors						
Sales Disc. / G.S.	.500	.691	.482	.705	1.000	.000
Sales R&A / G.S.	.000	1.000	.000	1.000	.500	.691
Materials / CoS	.000	1.000	.000	1.000	.000	1.000
Labor / CoS	.000	1.000	.000	1.000	.914	.001
Overhead / CoS	.000	1.000	.000	1.000	.500	.691
Expense / Related.	.000	1.000	.500	.691	.750	.500
Prepaid / Related.	1.000	.000	.250	.875	.000	1.000
Acc. Depr. / Related	.167	.911	.000	1.000	.292	.843
Bud Debt Exp. / H.S.	.000	1.000	.000	1.000	.000	1.000
Gross Margin Perc.	.240	.888	.182	.943	.500	.691
Receivables Turn.	.000	1.000	.500	.691	.799	.540
Finished Goods Turn.	.000	1.000	.000	1.000	.000	1.000
Allowance / Rec.	1.000	.000	.240	.875	.500	.691
Current Ratio	.250	.875	.250	.875	.500	.691
Quick Ratio	.000	1.000	.000	1.000	.522	.676
Op. Income / N.S.	.000	1.000	.000	1.000	.223	.902
Debt / Equity	.000	1.000	.000	1.000	.000	1.000

TABLE 2B - Continued.

Financial Relationships	September				December			
	Material Change		Yearly Change		Material Change		Yearly Change	
	Average	Confidence	Average	Confidence	Average	Confidence	Average	Confidence
Point-In-Time Individual Accounts - Type I Errors								
Net Sales . . . . .	1.000	---	.546	---	.750	---	.500	---
Cost of Sales . . . . .	1.000	---	.750	---	1.000	---	.500	---
Gross Profit . . . . .	1.000	---	.500	---	1.000	---	.500	---
Direct Materials . . . . .	1.000	---	.500	---	1.000	---	.500	---
Direct Labor . . . . .	1.000	---	.500	---	1.000	---	.832	---
Factory Overhead . . . . .	1.000	---	1.000	---	1.000	---	1.000	---
Bad Debt Expense . . . . .	1.000	---	.000	---	1.000	---	.000	---
Expense Accounts . . . . .	.800	---	.500	---	.867	---	.600	---
Total Admin. Exp. . . . .	1.000	---	.000	---	1.000	---	.500	---
Receivables . . . . .	1.000	---	.750	---	.501	---	.750	---
Inventory . . . . .	.356	---	.333	---	1.000	---	.500	---
Prop. Plant & Equip . . . . .	1.000	---	1.000	---	1.000	---	.499	---
Accounts Payable . . . . .	.762	---	.000	---	.475	---	.000	---
Accrued Liabilities . . . . .	.325	---	.000	---	.261	---	.000	---
Working Capital . . . . .	1.000	---	1.000	---	.806	---	.528	---
Point-In-Time Individual Accounts - Type II Errors								
Net Sales . . . . .	.000	1.000	.430	.744	.248	.878	.500	.691
Cost of Sales . . . . .	.001	1.000	.250	.875	.000	1.000	.500	.691
Gross Profit . . . . .	.000	1.000	.250	.875	.001	1.000	.500	.691
Direct Materials . . . . .	.000	1.000	.500	.691	.000	1.000	.500	.691
Direct Labor . . . . .	.000	1.000	.316	.829	.000	1.000	.036	1.000
Factory Overhead . . . . .	.000	1.000	.000	1.000	.000	1.000	.000	1.000
Bad Debt Expense . . . . .	.000	1.000	1.000	.000	.000	1.000	1.000	.000
Expense Accounts . . . . .	.200	.915	.500	.691	.135	.965	.400	.762
Total Admin. Exp. . . . .	.000	1.000	1.000	.000	.202	.914	.536	.667
Receivables . . . . .	.000	1.000	.250	.875	.251	.875	.250	.875
Inventory . . . . .	.605	.618	.625	.605	.468	.716	.439	.738
Prop. Plant & Equip . . . . .	.000	1.000	.000	1.000	.000	1.000	.500	.691
Accounts Payable . . . . .	.103	.934	.203	.918	.527	.676	.543	.664
Accrued Liabilities . . . . .	.565	.656	1.000	.000	.570	.646	1.000	.000
Working Capital . . . . .	.000	1.000	.000	1.000	.167	.941	.417	.750

combinations of analytic tests and financial relationships that are most reliable. Reliability was evaluated by the efficiency and effectiveness of the analytic tests applied to the financial ratios. The effectiveness associated with the procedure (analytic test and financial relationship) must meet the maximum AR specification (62.5 percent). Of the procedures that meet the effectiveness criterion, the two most efficient are selected. The analysis first addresses analytic tests applied on a monthly basis, followed by an analysis of point-in-time cutoff tests.

Monthly cutoff tests. The most reliable analytical procedures applied on a monthly basis are summarized in Table 29. For each financial relationship, the most efficient analytic tests are listed which provide at least 95 percent confidence that maximum AR is met. In other words, there is 95 percent confidence that the type II error rates are less than 62.5 percent.

The most reliable analytic tests are those analytic tests with the lowest type I error rates. The next most reliable analytic tests are those analytic tests with the next lowest type I error rate. The change in efficiency indicates the difference in the type I error rates between the most reliable and the next most reliable analytic tests.

The first nine financial ratios listed in Table 29 (Sales discounts to gross sales through bad debt expense to net sales) are considered audit specific ratios. These ratios cannot normally be derived unless access is gained to financial data which may not be found in published financial statements. The last eight financial ratios (gross margin percentage through debt to equity) are considered general ratios. The information needed to calculate these ratios is normally available in published financial statements.

TABLE 29  
RELATIVE RELIABILITY OF ANALYTIC TESTS  
ACROSS FINANCIAL RELATIONSHIPS

Financial Relationship	Most Reliable Analytic Test	Next Most Reliable Analytic Test	Change in Efficiency
Financial Ratios			
Sales Discount / G.S.	Numerator Bench. Regression	Denominator Bench. Numerator Bench. Regression	0.339
Sales RA / G.S.	Numerator Bench. Regression	Numerator Bench. Regression	0.075
Direct Materials / CoS.	Numerator Bench. Regression	Numerator Bench. Regression	0.021
Direct Labor / CoS.	10 Percent Change	Numerator Bench. Regression	0.161
Factory Overhead / CoS.	---	---	0.032
Expense Acct. / Related	---	---	---
Prepaid Acct. / Related	10 Percent Change	Denominator Bench. Numerator Bench. Regression	0.057
Acc. Depr. / Depr. Exp.	Numerator Bench. Regression	10 Percent Change	0.010
Bad Debt Expense / H.S.	Numerator Bench. Regression	Numerator Bench. Regression	0.110
Gross Margin Percent.	Denominator Bench. Regression	Numerator Bench. Regression	0.169
Receivables Turnover	10 Percent Change	Denominator Bench. Regression	0.042
Finished Goods Turnover	10 Percent Change	Denominator Bench. Regression	0.134
Allowance / Receivables	10 Percent Change	Denominator Bench. Regression	0.170
Current Ratio	Regression	---	---
Quick Ratio	Regression	10 Percent Change	0.082
Operating Income / H.S.	Regression	10 Percent Change	0.213
Debt / Equity	Regression	10 Percent Change	0.213
Individual Accounts			
Net Sales	Yearly Change	Material Change	0.086
Cost of Sales	Material Change	Time Series	0.030
Gross Profit	Yearly Change	Material Change	0.115
Direct Materials	Material Change	Time Series	0.048
Direct Labor	Material Change	Time Series	0.037
Factory Overhead	Material Change	Time Series	0.019
Bad Debt Expense	Material Change	Time Series	0.177
Expense Accounts	---	---	---
Total Administrative	Time Series	Material Change	0.073
Receivables	Time Series	Material Change	0.012
Inventory	Material Change	Time Series	0.049
Prop. Plant & Equip.	Yearly Change	Time Series	0.031
Accounts Payable	Material Change	Time Series	0.009
Accrued Liabilities	Time Series	Material Change	0.010
Working Capital	Yearly Change	Material Change	0.071

Table 29 indicates that the numerator benchmark analytic test is listed for six of the nine audit specific ratios. Regression appears four times, ten percent change appears three times, and the denominator benchmark appears twice. There does not appear to be any pattern to the combinations of first and second choices. Therefore, it is concluded that the numerator benchmark analytic test is, in general, the most reliable analytic test to combine with audit specific financial ratios.

Regression is listed for seven of the eight general financial ratios. The 10 percent change analytic test occurs as a choice for four of the general ratios. The denominator benchmark appears three times while the numerator benchmark appears only once. Hence, regression appears to be the most reliable analytic test to apply to general financial ratios.

Across all seventeen financial ratios, regression provides at least 83 percent confidence of meeting AR with an average type I error rate of 69 percent. The numerator benchmark provides at least 87 percent confidence of meeting AR with an average type I error rate of 83 percent. Thus, regression is recommended as the single technique to be applied across all financial ratios.

The first nine individual accounts are associated with the income statement. The material change analytic test is listed for eight of the nine income statement financial accounts, while time series is listed for six of the nine financial accounts. Hence, the material change analytic test appears as the best choice to consistently apply to income statement accounts.

The next five individual accounts (receivables through accrued liabilities) are associated with balance sheet accounts. The time series analytic test appears as the best choice to consistently apply to balance sheet accounts.

Across all individual accounts, the time series provides at least 90 percent confidence of meeting AR with an average type I error rate of 69 percent. The material change analytic test provides at least 80 percent confidence of meeting AR with an average type I error rate of 62 percent. Hence, the best single analytic test to apply across all individual accounts appears to be the time series. This also suggests that the structural technique with a statistical decision rule (regression and time series) is the best analytic test to apply across all financial relationships.

Two financial relationships did not meet the maximum AR across all analytic tests; namely, expense accounts to related accounts and individual expense accounts. Hence, these financial relationships do not provide reliable audit evidence when evaluated with the analytic tests included in this study. This could present a problem as analytical review is a primary approach to evaluating the income statement. It must be noted that a single expense account was evaluated from the income statements of both firms within this study. These results suggest that the particular expense account should not be evaluated with analytical review procedures. Additional research on other expense accounts must be conducted before any generalizations can be made concerning the appropriateness of applying analytical review procedures to expense accounts.

The likelihood estimates assessed from practicing auditors indicate that the first three income statement individual accounts (net sales, cost of sales, and gross profit) are analyzed on more than 90 percent of all audits. The analytic test most preferred by the practicing auditors (yearly change) is the most efficient test to apply to these accounts on a monthly basis (with 91 percent

confidence of meeting AR). Likewise, the traditional 10 percent change analytic test is the first or second choice for three of the seven financial ratios which are likely to be analyzed in more than 65 percent of the audits (with 94 percent confidence of meeting AR). These financial ratios are direct materials to cost of sales, finished goods turnover and operating income to net sales. There may be an implicit association in this data. The financial relationships most preferred by practicing auditors may be those that yield reliable results when evaluated with traditional techniques. The analysis in this study is too limited to address this question. It is necessary to evaluate the analytic tests with financial data from additional representative firms before any generalizations can be drawn.

Point-in-time tests. Analytic tests selected to evaluate financial relationships at a point-in-time should have consistent reliability levels for interim and end of period tests. Hence, the effectiveness associated with the analytic test should meet the maximum AR for both September and December points-in-time. Additionally, analytic tests which always signal investigations are not considered reliable with respect to providing audit evidence.

Only one analytic test applied to one individual account met these conditions; specifically, the material change analytic test applied to expense accounts. Hence, the analytic tests included in this study do not appear to provide reliable audit evidence when applied to financial relationships at a point-in-time.

During the analysis of the error size treatment, it was noted that the differences between the predicted values and the true values of the monthly ratios and account balances were found to exceed the precision of the analytic test in 96 percent of the months evaluated by applying analytic tests to financial ratios at a

point-in-time and 90 percent of the months evaluated by applying analytic tests to individual accounts at a point-in-time. The implication of this finding is that the point-in-time tests within this study have a greater tendency to signal investigations as a result of normal fluctuations in the financial data.

The poor performance of the point-in-time tests can be partially explained by the nature of the monetary errors seeded into the simulation process. A review of Table 13 indicates that thirteen of the thirty-three sources of monetary error which are most likely to result in a material error are cutoff errors. Cutoff errors only affect the financial balances of the months directly associated with the error, and do not affect the cumulative balances of financial accounts. Thus, unless the cutoff error occurs in September or December, point-in-time tests will not detect approximately 40 percent of the monetary errors most likely to occur, even under ideal conditions. This would result in higher type II error rates associated with those financial relationships affected by the cutoff errors.

Point-in-time tests should be capable of detecting permanent errors seeded into the financial balances. The effect of the financial relationships on the averaged error rates for point-in-time analytic tests are presented in Table 30. This data reflects only permanent errors in the financial balances. Financial relationships evaluated only against temporary errors were excluded from this analysis.<sup>8</sup> These financial relationships are sales discounts to gross sales, sales returns and allowances to gross

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<sup>8</sup>These financial relationships were first affected by temporary errors within the simulation process. The financial relationships may have been affected by permanent errors if additional replications were allowed within the simulation process.

TABLE 30  
EFFECT OF PERMANENT ERRORS IN THE FINANCIAL RELATIONSHIPS  
ON THE AVERAGED ERROR RATES OF POINT-IN-TIME ANALYTIC TESTS

Financial Relationship	Numerator Benchmark		Denominator Benchmark		10 Percent Change	
	Average	Confidence	Average	Confidence	Average	Confidence
September Point-In-Time Financial Ratios - Type I Errors						
Materials / CoS	1.000	---	1.000	---	.500	---
Labor / CoS	.500	---	.776	---	.000	---
Overhead / CoS	1.000	---	1.000	---	1.000	---
Expense / Related	.750	---	.500	---	.250	---
Prepaid / Related	.000	---	.500	---	1.000	---
Acc. Depr. / Related	.750	---	1.000	---	.938	---
Bad Debt Exp. / N.S.	1.000	---	1.000	---	1.000	---
Receivables Turn.	1.000	---	.500	---	.000	---
Finished Goods Turn.	.929	---	.526	---	.500	---
Allowance / Rec.	.000	---	1.000	---	.500	---
Current Ratio	1.000	---	1.000	---	.500	---
Quick Ratio	1.000	---	1.000	---	.750	---
Op. Income / N.S.	1.000	---	1.000	---	1.000	---
Debt / Equity	.750	---	.750	---	.750	---
September Point-In-Time Financial Ratios - Type II Errors						
Materials / CoS	.000	1.000	.000	1.000	.500	.689
Labor / CoS	.303	.850	.197	.941	1.000	1.000
Overhead / CoS	.000	1.000	.000	1.000	.000	1.000
Expense / Related	.250	.874	.500	.690	.750	.500
Prepaid / Related	1.000	1.000	.500	.690	.000	1.000
Acc. Depr. / Related	.184	.933	.070	.996	.115	.980
Bad Debt Exp. / N.S.	.000	1.000	.000	1.000	.000	1.000
Receivables Turn.	.000	1.000	.500	.689	1.000	1.000
Finished Goods Turn.	.049	1.000	.361	.797	.500	.689
Allowance / Rec.	1.000	1.000	.000	1.000	.500	.689
Current Ratio	.000	1.000	.000	1.000	.500	.691
Quick Ratio	.000	1.000	.000	1.000	.264	.866
Op. Income / N.S.	.000	1.000	.000	1.000	.000	1.000
Debt / Equity	.250	.875	.250	.875	.250	.875

TABLE 30 - Continued.

Financial Relationship	Numerator Benchmark		Denominator Benchmark		10 Percent Change	
	Average	Confidence	Average	Confidence	Average	Confidence
December Point-In-Time Financial Ratios - Type I Errors						
Materials / CoS	1.000	---	1.000	---	1.000	---
Labor / CoS	1.000	---	1.000	---	.000	---
Overhead / CoS	1.000	---	1.000	---	.500	---
Expense / Related.	1.000	---	.500	---	.250	---
Prepaid / Related.	.000	---	.750	---	1.000	---
Acc. Depr. / Related	.750	---	1.000	---	.750	---
Bad Debt Exp. / N.S.	1.000	---	1.000	---	1.000	---
Receivables Turn.	1.000	---	1.000	---	1.000	---
Finished Goods Turn.	1.000	---	1.000	---	1.000	---
Allowance / Rec.	.000	---	.538	---	.500	---
Current Ratio	.750	---	.731	---	.365	---
Quick Ratio	1.000	---	1.000	---	.750	---
Op. Income / N.S.	1.000	---	1.000	---	.500	---
Debt / Equity	1.000	---	1.000	---	.981	---
December Point-In-Time Financial Ratios - Type II Errors						
Materials / CoS	.000	1.000	.000	1.000	.000	1.000
Labor / CoS	.000	1.000	.000	1.000	.833	.587
Overhead / CoS	.000	1.000	.000	1.000	.500	.689
Expense / Related.	.000	1.000	.500	.690	.750	.500
Prepaid / Related.	1.000	1.000	.250	.874	.030	1.000
Acc. Depr. / Related	.167	.941	.000	1.000	.292	.843
Bad Debt Exp. / N.S.	.000	1.000	.000	1.000	.000	1.000
Receivables Turn.	.000	1.000	.500	.689	1.000	1.000
Finished Goods Turn.	.000	1.000	.000	1.000	.000	1.000
Allowance / Rec.	1.000	1.000	.500	.689	.500	.689
Current Ratio	.250	.875	.250	.675	.500	.691
Quick Ratio	.000	1.000	.000	1.000	.417	.750
Op. Income / N.S.	.000	1.000	.000	1.000	.500	.689
Debt / Equity	.000	1.000	.000	1.000	.000	1.000

TABLE 30 - Continued.

Financial Relationship	September				December			
	Material Change		Yearly Change		Material Change		Yearly Change	
	Average	Confidence	Average	Confidence	Average	Confidence	Average	Confidence
Point-In-Time Individual Accounts - Type I Errors								
Cost of Sales	1.000	---	.750	---	1.000	---	.500	---
Direct Materials	1.000	---	.500	---	1.000	---	.500	---
Direct Labor	1.000	---	.865	---	1.000	---	.962	---
Factory Overhead	1.000	---	1.000	---	1.000	---	1.000	---
Bad Debt Expense	1.000	---	.000	---	1.000	---	.000	---
Expense Accounts	.750	---	.250	---	.750	---	.500	---
Total Admin. Exp.	1.000	---	.000	---	1.000	---	.500	---
Receivables	1.000	---	.500	---	.500	---	.500	---
Inventory	.250	---	.250	---	.750	---	.750	---
Prop, Plant & Equip	1.000	---	1.000	---	1.000	---	.500	---
Accounts Payable	.796	---	.750	---	.269	---	.305	---
Accrued Liabilities	.401	---	.000	---	.250	---	.000	---
Working Capital	1.000	---	1.000	---	.865	---	.558	---
Point-In-Time Individual Accounts - Type II Errors								
Cost of Sales	.000	1.000	.250	.874	.000	1.000	.500	.690
Direct Materials	.000	1.000	.500	.690	.000	1.000	.500	.690
Direct Labor	.000	1.000	.021	1.000	.000	1.000	.000	1.000
Factory Overhead	.000	1.000	.000	1.000	.000	1.000	.000	1.000
Bad Debt Expense	.000	1.000	1.000	1.000	.000	1.000	1.000	1.000
Expense Accounts	.250	.874	.750	.500	.250	.874	.500	.690
Total Admin. Exp.	.000	1.000	1.000	1.000	.167	.939	.500	.689
Receivables	.000	1.000	.500	.689	.000	1.000	.500	.689
Inventory	.750	.500	.750	.500	.250	.874	.250	.690
Prop, Plant & Equip	.066	.999	.113	.986	.000	1.000	.500	.690
Accounts Payable	.421	.767	1.000	1.000	.667	.570	.750	.500
Accrued Liabilities	.000	1.000	.000	1.000	.125	.874	1.000	1.000
Working Capital	.000	1.000	.000	1.000	.125	.970	.375	.780

sales, bad debt expense to net sales, nets sales and gross profit.

The results in Table 30 indicate that some financial relationships are reliable when applied at a point-in-time. In general, point-in-time tests are not reliable. They tend to signal investigations in 100 percent of the months evaluated, even when temporary errors are excluded from the analysis.

Summary. In general, statistical and materiality-based decision rules incorporated into analytical review procedures and applied on a monthly basis appear to provide the most reliable results. In specific situations, the traditional techniques preferred by practicing auditors provide the most reliable evidence. However, these traditional techniques cannot be generalized across all financial relationships. Analytical review procedures applied for the purpose of attention directing or as substitute detailed tests should not be applied at a point-in-time.

#### Sensitivity to precision

The final analysis concerns the sensitivity of the error rates to various precisions incorporated into the decision rules. Five financial relationships were randomly chosen from the set of financial relationships, and re-evaluated incorporating low, medium and high levels of precision in the decision rules. For the traditional decision rules, a high precision interval was defined as plus or minus five percent while a low precision interval was defined as plus or minus fifteen percent. For the statistical decision rules, high precision was set at ten percent and low precision was set at fifty percent. These two levels are the extremes commonly suggested in authoritative literature.<sup>9</sup>

The results of the sensitivity analysis are presented in Table 31. The data in Table 31 were analyzed with the Friedman test, resulting in test statistics of 11.389 and 7.799 for type I and type II error rates, respectively. These test statistics suggest that alternative precision levels significantly affect the type I and type II error rates associated with alternative decision rules.

The multiple comparison procedure was applied to identify differences between precision levels. The results, summarized in Table 32, indicate a definite trend from low to high precision levels. Visual analysis of Table 31 reveals that high precision is associated with higher type I error rates and lower type II error rates for statistical and traditional decision rules.

For financial ratios, alternative precision levels do not produce significant trends in the error rates associated with the numerator benchmark and denominator benchmark tests. This is to be expected since these procedures are strictly based on material changes in the account balances and are not altered with varying levels of precision. The regression test tends to be more consistent across varying levels of precision than the 10 percent change test.

For individual accounts, the change in the error rates across the precision levels is not significant for the materiality-based analytic test -- material change. The statistical decision rule incorporated in the time series analytic test is less sensitive to varying precision levels than the traditional decision rules -- yearly change and monthly change.

These results suggest that the materiality-based decision

TABLE 31  
EFFECT OF DECISION RULE PRECISION ON THE  
AVERAGED ERROR RATES OF ANALYTIC TESTS

Analytic Tests	High - .05/.10		Inter. - .10/.36		Low - .15/.50		Relative Variation
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.	
Financial Ratios - Type I Errors							
Monthly Cutoff Tests							
Numerator Benchmark . . . . .	.742	.205	.752	.210	.747	.205	.0064
Denominator Benchmark . . . . .	.599	.299	.608	.305	.612	.298	.0107
10% Percent Change . . . . .	.506	.107	.225	.234	.075	.116	.8142
Regression . . . . .	.586	.433	.541	.425	.504	.412	.0754
September Point-In-Time							
Numerator Benchmark . . . . .	1.000	.000	1.000	.000	1.000	.000	.0000
Denominator Benchmark . . . . .	.333	.473	.333	.473	.333	.473	.0000
10% Percent Change . . . . .	.333	.473	.111	.315	.000	.000	1.1456
December Point-In-Time							
Numerator Benchmark . . . . .	.667	.473	.667	.473	.667	.473	.0003
Denominator Benchmark . . . . .	.000	.000	.000	.000	.000	.000	.0000
10% Percent Change . . . . .	.333	.473	.111	.315	.000	.000	1.1456
Financial Ratios - Type II Errors							
Monthly Cutoff Tests							
Numerator Benchmark . . . . .	.181	.182	.180	.185	.189	.198	.0200
Denominator Benchmark . . . . .	.290	.248	.288	.252	.298	.257	.0176
10% Percent Change . . . . .	.491	.124	.773	.246	.928	.116	.3034
Regression . . . . .	.268	.370	.316	.386	.351	.382	.1339
September Point-In-Time							
Numerator Benchmark . . . . .	.000	.000	.000	.000	.000	.000	.0000
Denominator Benchmark . . . . .	.667	.473	.667	.473	.667	.473	.0003
10% Percent Change . . . . .	.667	.473	.889	.315	1.000	.000	.1992
December Point-In-Time							
Numerator Benchmark . . . . .	.333	.473	.333	.473	.333	.473	.0000
Denominator Benchmark . . . . .	1.000	.000	1.000	.000	1.000	.000	.0000
10% Percent Change . . . . .	.667	.473	.889	.315	1.000	.000	.1992

TABLE 31 - Continued.

Analytic Tests	High - .05/.10		Inter. - .10/.36		Low - .15/.50		Relative Variation
	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.	
Individual Accounts - Type I Errors							
Monthly Cutoff Tests							
Material Change . . . . .	.558	.324	.550	.321	.553	.321	.0083
Yearly Change . . . . .	.329	.338	.213	.262	.109	.151	.5053
Monthly Change . . . . .	.401	.347	.345	.305	.267	.267	.2001
Time Series . . . . .	.647	.376	.568	.361	.501	.335	.1281
September Point-In-Time							
Material Change . . . . .	.519	.494	.516	.456	.510	.498	.0091
Yearly Change . . . . .	.056	.201	.056	.201	.000	.000	.8660
December Point-In-Time							
Material Change . . . . .	.500	.502	.500	.502	.500	.502	.0000
Yearly Change . . . . .	.000	.000	.000	.000	.000	.000	.0000
Individual Accounts - Type II Errors							
Monthly Cutoff Tests							
Material Change . . . . .	.294	.229	.270	.227	.259	.221	.0657
Yearly Change . . . . .	.678	.336	.792	.291	.895	.179	.1374
Monthly Change . . . . .	.541	.406	.573	.377	.625	.381	.0731
Time Series . . . . .	.081	.152	.125	.172	.166	.188	.3444
September Point-In-Time							
Material Change . . . . .	.345	.461	.339	.459	.354	.466	.0225
Yearly Change . . . . .	.046	.349	.846	.349	1.000	.000	.0988
December Point-In-Time							
Material Change . . . . .	.578	.405	.581	.486	.584	.488	.0053
Yearly Change . . . . .	1.000	.000	1.000	.000	1.000	.000	.0000

TABLE 32  
 COMPARISON OF THE EFFECTS OF PRECISION ON  
 THE AVERAGED ERROR RATES

Type I Error Rates

	Inter. - .10/.36	High - .15/.50
Low - .05/.10 . : Inter. - .10/.36 . :	Similiar ---	Different Similiar

Type II Error Rates

	Inter. - .10/.36	High - .15/.50
Low - .05/.10 . : Inter. - .10/.36 . :	Similiar ---	Different Similiar

rules provide more consistent results across varying levels of precision. Analytic tests which incorporate statistical decision rules result in decreasing type I error rates and increasing type II error rates as precision decreases from high to lower levels. However, the relative variation of this precision effect is small when compared to the relative variation from other treatments within the study.

#### Analysis with parametric models

The results of the simulation model were also evaluated with an analysis of variance (ANOVA) model. Some of the assumptions of the ANOVA model were not met; specifically, the need for a completely randomized design and the requirement of homogeneous variances. Thus, application of the ANOVA model to the data within this study may not produce statistically reliable results. The results are presented for informational purposes.

The effects of the firm, time period per firm and test cutoff treatments were evaluated with a three-way nested-factorial ANOVA model. Only the firm treatment was significant. The effects of the time period per firm and cutoff test treatments were not significant. The interaction between the time period per firm and the cutoff test was also not significant. The descriptive analysis presented earlier produced similar conclusions.

The effects of the analytic test, error size and error distribution were evaluated with a three-way factorial ANOVA model. The effect of the error size treatment was not significant. The effects of the analytic test and error distribution treatments were significant. A significant interaction occurred between the analytic test and error distribution treatments. All other interactions were not significant. The descriptive analysis also

suggests that the error size is not significant. Analysis of the error distribution treatment (Table 26) validates the interaction between distribution and analytic test treatments. The error rates for some analytic tests remain essentially constant while the error rates for other analytic tests change across the error distribution treatment.

The effects of the analytic test, error direction and error distribution were evaluated with a three-way factorial ANOVA model. All three treatments produced significant results. A significant interaction occurred between the analytic test and the error distribution. The descriptive analysis also suggested that the error direction treatment was significant.

The effects of the analytic test, financial relationship and error distribution were analyzed with a three-way factorial ANOVA model. All main effects, two-way interactions and the three-way interaction were found to be significant. A review of Table 28 validates the interaction between the analytic test and the financial relationship. The changes in the error rates associated with the financial relationships are not consistent across the analytic test treatment. A descriptive analysis was not performed for the interaction of the financial relationship and error distribution treatment. However, a interaction was found in the descriptive analysis between the financial relationship and error size treatments. Hence, it is likely that the error rates associated with a financial relationship do change at different rates across the error distribution treatment.

Finally, the effects of the analytic test, precision of the decision rule, and error distribution were evaluated with a three-way factorial ANOVA model. All main effects were found to be significant. Significant interactions occurred between the analytic

test and the distribution and between the analytic test and the precision of the decision rule. During the descriptive analysis, it was noted that the materiality-based decision rules were relatively constant across varying levels of precision, while the statistical and traditional decision rules produced different error rates at different levels of precision. Hence, a significant interaction between the analytic test and the precision of the decision rule does appear to exist.

The conclusions derived from analyzing the data with the ANOVA model are similar to the conclusions derived from the descriptive analysis. The ANOVA models provide additional evidence that the error size treatment does not significantly influence the type I and type II error rates within this study. All other treatments appear to have significant effects.

#### Summary of results

Statistical decision rules should be applied on a monthly basis to general financial ratios and individual balance sheet accounts. The resulting analytical review procedures:

- a. Provide 95 percent confidence that the effectiveness will be less than 62.5 percent, meeting the maximum allowable risk for incorrect acceptance.
- b. Are sensitive to changes in firm.
- c. Have the highest sensitivity to changes in the distribution of the error, becoming less efficient but more effective as the number of months tested are increased.
- d. Tend to be more effective and less efficient as the size of the error increases.
- e. Show some sensitivity to changing levels of beta risk incorporated into the statistical decision rule.

f. Are sensitive to changes in the direction of the monetary error under specific economic conditions.

Materiality-based decision rules should be applied to audit specific financial ratios (numerator benchmark) and individual income statement accounts (material change) on a monthly basis. The resulting analytical review procedures:

a. Provide 95 percent confidence that the effectiveness will be less than 62.5 percent, meeting the maximum allowable risk for incorrect acceptance.

b. Are less sensitive to changes in firm than the statistical decision rules.

c. Show some sensitivity to changes in the distribution of the monetary error. The influence of varying distributions is analogous to the statistical decision rule.

d. Tend to be more effective and less efficient as the size of the error increases.

e. Do not explicitly incorporate precision in the decision rule, and thus are not sensitive to varying levels of precision.

f. Are sensitive to changes in the direction of the monetary error under specific economic conditions.

The above analytical review procedures should not be applied to investigate systematic errors in the financial data unless such systematic errors are highly likely. The auditor should plan the audit procedures based on an evaluation of the firm and its internal control system. If the auditor suspects that non-systematic errors have entered the financial account balances, then analytical procedures applied to detect non-systematic errors may be effective in detecting the presence of such errors. If the

auditor suspects that systematic errors are present in the financial balances, then analytical review procedures applied to detect systematic errors should be effective. However, the auditor may prefer to perform compliance testing and direct tests of transactions and balances due to the high type I error rates of the analytical review procedures. These results suggest that the auditor should not rely on any one component of the audit risk model. Although the results of one component may be used to reduce the extent of testing in another component area, all components should be included in the audit plan.

Additionally, analytical review procedures should not be generally applied at a point-in-time. Specific procedures may be both effective and efficient when applied at interim or year-end cutoff. However, the analytical review procedures evaluated in this study tend to be inconsistent when applied at a point-in-time, and may not provide adequate assurance that ultimate audit risk is maintained at acceptable levels.

#### Selection Guidelines

The results of the simulation process are used to select those analytic tests which are expected to be the most reliable when applied to a set of financial relationships. These analytic tests and the associated financial relationships are depicted in Table 33. For each financial relationship, the average type I and type II error rates associated with the analytic test are also presented.

Across the top of Table 33, the potential sources of monetary error considered most likely to result in a material error within any given audit are listed. Material monetary errors could result either from a single source or from related sources. The 30

TABLE 33  
GUIDELINES FOR SELECTING ANALYTICAL REVIEW PROCEDURES

Potential Sources of Monetary Error	Likelihood of material errors from: Individual error sources Related error sources											
	Type I .6020		Type II .2040		Type III .0340		Type IV .0950		Type V .1190		Type VI .0200	
Sales Discounts / Gross Sales . . . . .	X	X	X	X	X	X	X	X	X	X	X	X
Sales Returns and Allowances / Gross Sales . . . . .	X	X	X	X	X	X	X	X	X	X	X	X
Direct Materials / Cost of Sales . . . . .	X	X	X	X	X	X	X	X	X	X	X	X
Direct Labor / Cost of Sales . . . . .	X	X	X	X	X	X	X	X	X	X	X	X
Factory Overhead / Cost of Sales . . . . .	X	X	X	X	X	X	X	X	X	X	X	X
Accumulated Depreciation / Related Asset Account . . . . .	X	X	X	X	X	X	X	X	X	X	X	X
Bad Debts Expense / Net Sales . . . . .	X	X	X	X	X	X	X	X	X	X	X	X
Gross Margin Percentage . . . . .	X	X	X	X	X	X	X	X	X	X	X	X
Receivables Turnover . . . . .	X	X	X	X	X	X	X	X	X	X	X	X
Finished Goods Turnover . . . . .	X	X	X	X	X	X	X	X	X	X	X	X
Allowance for Bad Debts / Receivables . . . . .	X	X	X	X	X	X	X	X	X	X	X	X
Current Ratio . . . . .	X	X	X	X	X	X	X	X	X	X	X	X
Quick Ratio . . . . .	X	X	X	X	X	X	X	X	X	X	X	X
Income from Operations / Net Sales . . . . .	X	X	X	X	X	X	X	X	X	X	X	X
Debt to Equity . . . . .	X	X	X	X	X	X	X	X	X	X	X	X

Likelihood of material errors from: Individual error sources Related error sources											
Type I .6020		Type II .2040		Type III .0340		Type IV .0950		Type V .1190		Type VI .0200	
Goods shipped but not invoiced	2	4	7	4	2	6	2	3	1	3	5
Sales recorded but goods not shipped	4	1	4	1	4	1	4	1	4	1	4
Wrong quantity shown on shipping document and sales invoice	1	4	1	4	1	4	1	4	1	4	1
Wrong period credited for sale	4	1	4	1	4	1	4	1	4	1	4
Billing terms incorrect	1	4	1	4	1	4	1	4	1	4	1
Goods returned but not reentered into inventory system	2	1	3	1	2	6	2	3	1	3	5
Wrong quantity/price credited for returned goods	1	3	1	3	1	3	1	3	1	3	5
Wrong period credited for sales return	3	1	3	1	3	1	3	1	3	1	3
Wrong period credited for allowance	2	4	2	4	2	4	2	4	2	4	2
Cash recorded in wrong period	3	8	3	8	3	8	3	8	3	8	3
Uncollectible accounts not written-off	6	10	6	10	6	10	6	10	6	10	6
Failure to provide adequate product warranty liability	5	7	5	7	5	7	5	7	5	7	5
Liability incurred but not recorded	9	10	9	10	9	10	9	10	9	10	9
Purchases recorded but goods not received	1	4	1	4	1	4	1	4	1	4	1
Purchases incorrectly valued	3	5	3	5	3	5	3	5	3	5	3





TABLE 33 - Continued.

Likelihood of material errors from: Individual error sources Related error sources	Type I		Type II		Purchases recorded in wrong period	Wrong period credited for purchases return	Payment recorded in wrong period	Duplicate payments	Failure to include items that should be accrued	Accruals recorded in wrong period	Incorrect handling of end-of-period accruals	Hours required to manufacture a unit recorded incorrectly	Obsolete items maintained in inventory	Material requisitions not recorded	Material requisitions recorded in wrong period	Costs of material, labor and overhead incorrectly recorded	Cost of material, labor and overhead incorrectly valued	Goods shipped too early or too late	
	.8400	.6930	.0930	.0800															
Net Sales . . . . .					5	1	3	1	9	4	3	3	4	2	4	2	3	2	
Cost of Sales . . . . .	.8690		.0800		9	7	4		10	8	5	5	10	4	4	3	3		
Gross Profit . . . . .	.8370		.0750									X		X	X	X	X		
Direct Materials . . . . .	.8990		.0570			X				X		X			X	X	X		
Direct Labor . . . . .	.7550		.0990							X		X							
Factory Overhead . . . . .	.9410		.0520							X					X	X	X		
Bad Debt Expense . . . . .	.2810		.3100																
Expense Accounts . . . . .	.4820		.4390							X					X	X	X		
Administrative Expenses . . . . .	.7260		.2340							X					X	X	X		
Receivables . . . . .	.7460		.1560																
Inventory Accounts . . . . .	.7330		.1230			X						X			X	X	X		
Property, Plant and Equipment . . . . .	.8670		.0820												X	X	X		
Trade Accounts Payable . . . . .	.7620		.1450			X		X											
Accrued Liabilities . . . . .	.4550		.1640				X	X	X										
Working Capital . . . . .	.9910		.0930			X	X	X	X	X			X		X	X	X		

sources considered most likely within each category were selected for inclusion in the selection guidelines. Overlap between the categories reduced the total number of error sources to 33. For each potential error source, the likelihood of material errors resulting from single sources and related sources are presented in Table 33.

Table 33 provides information which allows the auditor to select the most efficient set of analytical review procedures for the errors considered most likely to occur in the specific audit. One potential use of the guidelines in Table 33 is the development of a minimal set of analytical review procedures for audits of medium-sized manufacturing firms. If all the analytical procedures listed in Table 33 were included in this minimal set, only one potential error source would be excluded - incorrect handling of end of period accruals. However, other financial accounts would be indirectly affected by such errors. Thus, analytical review procedures may be able to detect monetary errors from this source by analyzing the financial balances in the related accounts.

The minimal set of analytical review procedures also gives coverage to other less critical error types. Of the 106 potential sources of monetary error, only seven are not covered by the analytical review procedures in Table 33. These potential sources are listed in Table 34. Note that most of these potential sources not covered by the minimal set are classification errors.

The simulation process developed within this study suggests that it is feasible to develop computer programs which apply these analytical review procedures without requiring any human action. The structural models are simple in form, and do not require selection of additional parameters to include as independent variables. Provided that monthly financial data is available in

TABLE 34

POTENTIAL SOURCES OF MONETARY ERROR  
NOT COVERED BY SELECTION GUIDELINES

Code	Monetary Error Source
11	Sales classified erroneously as to type
18	Billing of wrong customer
35	Cash credited to wrong sub-account
47	Purchases incorrectly classified
63	Related expenses are not properly classified
71	Related expenses not properly classified
80	Incorrect handling of end-of-period accruals
81	Expense reimbursement inaccurately calculated
84	Labor performed but not correctly allocated
92	Material requisitions incorrectly classified
95	Costs of material, labor and overhead incorrectly classified

computer-readable form, a program can be developed which performs this minimal set of analytical review and summarizes the results.

Another potential application of the selection guidelines in Table 33 involves searching for errors from specific potential sources. Assume that after evaluating the system of internal control, the auditor suspects inadequate controls for billing transactions. Errors resulting from "billing terms incorrect" affect numerous financial relationships. The issue is whether the errors detected by the analytical review procedures can be directly attributed to "billing terms incorrect."

One method for investigating this issue is termed triangulation. The objective is to isolate the sources of the errors detected by multiple analytical review procedures. For the above example, the auditor might evaluate sales discounts to gross sales and sales returns and allowances to gross sales. Review of Table 33 indicates that many sources of error are common to these two procedures. However, billing terms incorrect does not influence sales returns and allowances to gross sales.

Assume that the results of applying these two tests are different. This suggests that the procedures are influenced by errors that are not common. If the review of internal control indicates adequate control for errors resulting from sales return and allowance transactions, the auditor may be able to conclude that the difference in the results of applying the analytical review procedures was caused by inadequate control of billing transactions.

If the results of the analytical review procedures are not different, no general conclusions may be drawn. There may be offsetting errors resulting from billing transactions, or errors may result from both billing transactions and sales return and

allowance transactions.

#### Summary

This chapter has integrated the results of the simulation process with the results of the auditor survey to form selection guidelines. The selection guidelines suggest combinations of analytic tests and financial relationships which may be combined into analytical review procedures that provide 95 percent confidence that the maximum risk of incorrect acceptance is less than 62.5 percent. Application of these analytical review procedures during an audit of a medium-sized manufacturing firm would detect material errors from all but one of the potential sources most likely to result in a material error. This assumes that offsetting errors do not occur.

## CHAPTER VI

### LIMITATIONS OF THE STUDY

#### Introduction

The scope of this study is limited to analytical review procedures employed during audits of medium-sized manufacturing firms. Areas in which the scope of the study could be expanded are discussed in the next chapter as areas of future research. This chapter will address limitations in the results of the study. Hence, it concerns issues which arise within the scope of this study.

Kerlinger states that a basic criterion of a research study is generalizability: To what extent can the results of the study be generalized to other conditions?<sup>1</sup> Generalizability is related to the external validity of the results.

According to Abdel-khalik and Ajinkya, there exists a tradeoff between internal validity and external validity. Internal validity addresses the significance of experimental manipulation. External validity addresses the representativeness of the relations found in the experiment.<sup>2</sup> Hence, studies designed with

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<sup>1</sup>Fred N. Kerlinger, Foundations of Behavioral Research (New York: Holt, Rinehart and Winston, 1964), p. 412.

<sup>2</sup>A. Rashad Abdel-khalik and Bipin B. Ajinkya, Empirical Research in Accounting: A Methodological Viewpoint (Sarasota, Florida: American Accounting Association, 1979), p. 47.

excellent experimental control may not be generalizable, and studies designed to allow broad generalizations may not have sufficient experimental control.

The internal and external validity of this study will be addressed in turn. A model of total survey error developed by Kish will be used as a basis to discuss the limitations with respect to internal validity. Examination of the external validity will center on analysis of the representativeness of the samples employed, environmental conditions and control variables. Once the representativeness of the elements within the study is established, the generalizability of the results is discussed.

#### Model of Total Survey Error

One goal in the design of this study was to minimize the total survey error within time and monetary cost constraints. Kish defines several components which affect the total survey error within an experiment. The two main categories of total error are variable error and bias.<sup>3</sup> These components, depicted in Figure 10, are described in this section and applied to this study in the next section.

#### Variable errors

Variable error is generalized to include all error sources that result in a difference between an estimate based on a particular sample and the results that would be obtained if the estimate was averaged over all possible samples. Variable errors will fluctuate if different samples are selected using the same research design. Reduction of variable errors depends on

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<sup>3</sup>Kish, 509-71.

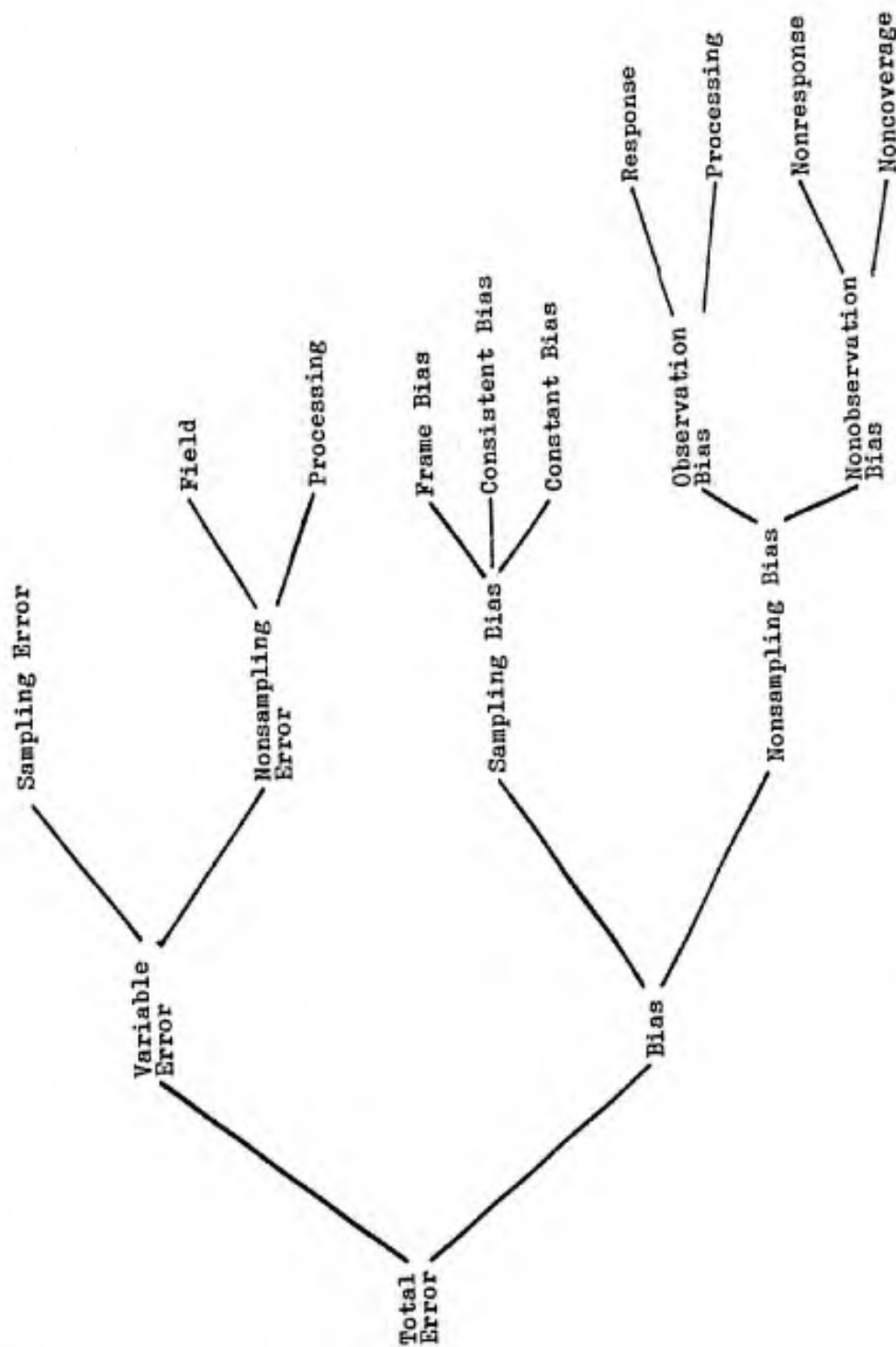


Fig. 10. Model of total survey error.

increasing the sampling units or the number of observations.

Variable errors are assumed to be random in nature, and relate to the precision of the sample. Smaller standard errors associated with the sample indicates that the measured data is more precise than samples having larger standard errors. Imprecise data complicates the analysis process. It is difficult to distinguish whether two variables are truly related or whether the two variables seem unrelated due to imprecise measurement of the variable.

There are two types of variable errors: sampling and nonsampling. Sampling errors account for most of the variable errors of a survey. Such errors arise because only a subset of the population is used in the sample. The expected value of sampling error is zero.

Nonsampling errors are sample-specific errors arising from sources other than sample selection. There is always the possibility that an error may occur which is more serious than might be caused by minor fluctuations of chance. Nonsampling errors may be further classified as field errors, stemming from the use of multiple interviewers or the interviewing process, or processing errors resulting from the editing of responses or data transposition errors.

### Bias

Bias is generalized to include all error sources that would produce a difference between the average of the survey estimate, taken over all possible samples, and the true population parameter for which the estimate is sought. Bias refers to systematic errors that affect any sample taken under a specific survey design with the same constant error. Biases cannot be reduced by increasing

the size of the sample. Reduction is achieved only through improving the quality of some operation. But, since the bias is systematic, it may have only negligible effects when analysis is based on a comparison of means.

There are also two types of bias: sampling and nonsampling. Sampling bias includes those systematic errors resulting from either the sampling process itself or from the statistical estimation process. The sampling bias attributable to sampling frame sources, such as inappropriate selection procedures, is probably the most serious.

Consistent bias refers to the use of biased but consistent estimators whose values vary with the size of the sample; for example, the use of  $[\sum (y_i - \bar{y})^2 / n - 1]$  as an estimate of  $\sigma^2$

For fixed sample sizes, this bias has a consistent effect on the estimate. Constant bias has an equal effect regardless of the sample size. For example, the use of the median to estimate the mean of a skewed distribution will result in constant bias.

The largest source of total error probably results from nonsampling bias. Biases of observation are caused by obtaining and recording observations incorrectly. Response bias arises during the collection of observations, and includes interviewing and measuring problems. The respondent may make errors in judgement which result in consistent overestimates or underestimates of the desired information. Processing biases occur while translating the data into a useable form for analysis.

Nonobservation biases arise from failure to obtain observations on some segment of the population. Nonresponse refers to failure to obtain observations on elements designated for the sample. Noncoverage denotes failure to include some elements of the defined survey population in the actual operational sampling

frame. The distinction between noncoverage and frame bias is in the probability of selecting the element for the sample. Noncoverage implies a zero probability of selection while frame bias implies some non-zero, but incorrect, probability of selection.

#### Internal Validity

The model of total survey error will now be applied to this study to analyze the extent and impact of variable error and bias.

#### Variable error

It is difficult to control sampling error. Normally, sampling error is controlled by increasing the sample size until the sample variability is acceptably low. Within this study, low sampling variability is obtained through repeated measurements. There is no reason to believe that the expectation of sampling error is other than zero.

Field errors which result from interviewer errors have been reduced through the use of only one interviewer. Possible processing errors have been reduced by extensive data verification procedures and the corroboration process. Even if some of the data collected during the initial interviews was processed incorrectly, the corroboration process should reduce the amount of measurement error introduced by processing.

#### Bias

Frame bias is the major source of bias within this study. Probability sampling was not feasible, resulting in the use of purposive sampling. Individuals were selected on the criterion that they be representative of the population as a whole. Time and

cost constraints limited the sampling frame to two audit firms. As a result, frame bias may result due to the affiliation of the participants with only two audit firms.

Frame bias is also present in the selection of the firms providing financial data. Firms selected were considered to be representative of medium-sized manufacturing operations. However, each manufacturing firm is considered to be unique in some respect. Even if random sampling had been employed, firm differences would still be expected.

Another frame bias problem is the small size of the samples. The recommended size for the estimate-feedback-estimate procedure is ten to twelve. Thirteen participants were used for the initial interviews. Although the size is relatively small, the sample is large enough to provide adequate information for the assessment technique applied.

The use of only two firms as the basis of the financial accounting models is a more serious limitation. This small size, coupled with the non-random selection, provides no statistical control over extraneous variables which affect the data in the financial statements. Thus, significant bias may exist in the financial data which would influence the results of this study.

The amount of observation bias was controlled during the collection process. This observation bias can be categorized as interviewer bias and participant bias.

Interviewer bias may take the following forms:

- a. Bias in asking questions. This bias may result from the use of voice inflection during the interview or changing the wording of the questions. This bias was reduced by providing a copy of the interview guide to the participants.

- b. Personal opinion biases of the interviewer. Such

biases occur when the interview attempts to elicit a preferred response from the participant. This form of bias was reduced through the use of a structured interview guide.

c. Misunderstanding of the participant's response. Follow-up telephone interviews and the corroboration process of the estimate-feedback-estimate technique should have reduced this form of bias in the study.

d. Inadequate interview guide. It is possible that the questions were ambiguous. Pretesting of the interview guide and the follow-up questionnaire should have reduced such biases in this study, but cannot eliminate them. Interviewer bias is further reduced through the use of the structured interview. Participants were encouraged to ask for clarifications when needed. Additionally, the interviewer kept records of clarifications to ensure consistency across the interviews.

Bias from the participants may take the following forms:

a. Misunderstanding of the question. The personal interview was the major control over this factor. The estimate-feedback-estimate process also added control. The participant may realize that he initially misinterpreted the question as a result of the feedback, and adjust his corroborating response accordingly.

b. Multiple treatment biases resulting from the cognitive phenomenon that exposure to one treatment cannot be totally erased when the next treatment is evaluated. While the first evaluation of a participant on the characteristics of an error may be valid, following evaluations may be biased as a result of the first response. Structuring the interview guide and followup questionnaire to separate related questions should have reduced such biases, but cannot eliminate them.

c. Familiarity with specific audit procedures and techniques may bias responses concerning the use of such techniques. It is possible that some viable audit procedures were not evaluated within this study because the participants, as a whole, are not familiar with such techniques.

Noncoverage bias results since participants were selected from only two national accounting firms. Firm differences in the use of analytical techniques are known to exist. It is assumed that the participants are representative of industry experts within their firms. It is acknowledged that the participants may not be representative of industry experts of other firms.

Nonresponse bias did occur in the followup questionnaire. In many studies, the effect of nonresponse bias cannot be determined since the characteristics of the nonrespondents cannot be established. Within this study, all participants completed the personal interview. Four of the thirteen follow-up questionnaires were not received, two due to noncompletion and two apparently lost in the mail. The differences in the responses for the personal interviews can be used to determine the nonresponse bias for the follow-up questionnaires.

The mean response of the participants completing the follow-up questionnaire was used to establish the relative likelihood of monetary error sources and the frequency with which analytical relationships are applied. This mean response was used as an estimate of the sample mean,  $\bar{Y}$ . The sample mean is a weighted average of the respondent mean and the non-respondent mean. If the nonresponse mean differs only slightly from the response mean, then the nonresponse bias will remain small.

Assuming that the estimates obtained from the participants are normally distributed, the equality of the two means can be

statistically tested. The standardized score of the difference between the two means is computed and compared to number of standard units from the normal distribution. For potential monetary error sources, the standardized difference is 0.4455. For the frequency of analytical procedures, the standardized difference is 0.5173. Both values are below the 95 percent probability level of 1.96 deviations. Thus, the null hypothesis that the two means are equal cannot be rejected, implying that non-response bias is negligible.

Processing bias was controlled through cross-check and validation procedures. Consistent and constant biases associated with statistical estimators are also assumed to negligible.

A deficiency in the simulation process was discovered during the investigations of the non-increasing trends of the error size treatment (see Chapter 5). In the simulation process, 23 different error distributions were used as the basis for seeding monetary errors in the financial data. Of these, nine were based on the random selection of the month to be seeded. It was found that the probabilities of selecting any one month were not equal. That is, some months had a higher probability of being selected than other months.

Subsequent testing of the random number generator used in the simulation process revealed that the distribution of the random numbers resembles a normal distribution rather than a uniform distribution. The process of selecting a random month was based on dividing the uniform distribution into twelve equal-sized categories, one for each month. Since the resulting distribution is more normal than uniform, the probability of selecting a month from the middle section is higher than the probability of selecting a month from either end of the distribution. This results in a

systematic bias that affects all analytic tests within the study. Such systematic bias should not adversely affect the results of the study with respect to the relative performance of the analytical review procedures.

#### Assessment of total error

The major component of total error within this study appears to result from frame bias and noncoverage. All other biases and errors are assumed to have a minimal impact on the results.

The systematic bias in the participants responses has little impact on the results of this study. The participants are considered to be a homogeneous group. Hence, the estimate-feedback-estimate process should perform as expected and reduce the variability among the participants estimates.

Another consideration is the use of the estimates. The estimates concerning the frequency with which analytical techniques are applied during an audit were used to develop a categorical ranking of the analytical techniques. A high degree of consensus was achieved for those procedures which were not frequently used. These procedures were excluded from the analysis. Most variation in the estimates occurred for those procedures classified in high usage categories. Since all of these procedures were included in the simulation process, there is minimal impact from the apparent disagreement.

The estimates concerning the likelihood of a material error entering the financial statements were used to produce a relative ranking of the potential error sources. The purpose of the relative ranking was to control the order with which potential error sources were introduced into the simulation process. The variability in these estimates appeared constant across the range

of likelihood estimates. This variability could make a difference in whether a potential error source was introduced into the simulation process.

The simulation process continued until each analyzed financial relationship was evaluated three times. The use of a different error source for the seeding of the monetary error may result in a different monetary amount of error. But for most situations, the monetary amount of error had no significant impact on the type I and type II error rates.

Thus, measurement error in the survey data should not influence the results of this study. But biases also exist in the financial data sets. There was a significant difference in the type I and type II error rates associated with the firms. The time period did not appear to have a significant impact. Even though there was a firm difference, the relative performance across firms appeared consistent when monthly cutoff tests were applied. Thus, the use of different financial data sets may affect the resulting type I and type II error rates, but the relative performance of the analytical procedures should be consistent. While no general conclusions can be drawn from data of only two firms, it appears that this firm bias does not affect the results of this study.

#### External Validity

External validity concerns the representativeness of the study. If the study can be considered representative of a specific environment, then the results of the study may be generalized to that environment. It is desirable that the results of this study be generalizable to audits of medium-sized manufacturing firms. Hence, the representativeness of the samples, economic conditions, and control parameters must be assessed with respect to medium-

sized manufacturing firms.

Representativeness of samples

Would there be a significant difference in the relative rankings of the likelihood of monetary errors or the frequency with which analytical procedures are used if a different group of auditors participated in the study? It is likely that there would be a difference in the analytical procedures. The authoritative pronouncements concerning the use of analytical review procedures are not specific. It is well known that national accounting firms have different philosophies concerning the extent to which analytical review procedures are applied. So it is feasible that auditors with more or less experience in the use of analytical review would have different experiences with respect to the frequency of use.

It is less likely that a different group of auditors would have totally different opinions on the likelihood of material errors. This study assumes that such errors result from the processing of transactions. Although the transaction processing systems of manufacturing firms do vary, it is not expected that this variation is related to the auditor employed by the firm. There should be no relation between the likelihood of a material error in the financial statements and the audit processes used by the various firms.

Are the financial data sets used within this study representative of medium-sized manufacturing firms? In discussions with practicing auditors during the personal interviews, there was a general consensus that there is not a representative manufacturing firm. So the question should be directed toward whether different sets of financial data change the

relative performance of the analytical procedures evaluated within this study. There is not sufficient evidence to conclude whether there will or will not be a firm effect with respect to the relative performance of procedures.

Finally, are the financial data sets of firms within the manufacturing industry representative of firms outside the manufacturing industry? It is speculated that many common accounting aspects exist between any two specific industries. Thus, in specific situations, the results of this study may be generalizable to another industry.

#### Representativeness of economic conditions

It was shown in chapter 5 that economic conditions do impact the performance of analytical procedures. The economic conditions for this study are representative of inflationary growth environments. However, generalization outside of economic conditions similar to the 1976 to 1981 time frame is not recommended without further analysis of the impact on the analytical procedures.

#### Representativeness of control variables

The basic control variables in the study were error size, error distribution, firm, and analytical procedure. As already discussed, the analytical procedures were derived from survey data, and are not expected to vary if a different sample was used.

The use of financial data from different firms is likely to change the evaluations of efficiency and effectiveness of the analytical review procedures. However, the relative performance of the procedures should not change. Hence, the level of reliability

may change, but recommended procedures should remain the most reliable.

Varying the size of the error did not significantly affect the type I and type II error rates. While increasing the size of the error beyond two times a material amount may reduce the type II error rate, there is no reason to expect such an increase to alter the relative performance of the procedures.

Changing the distribution of the monetary error does affect the type I and type II error rates. Thus, additional research must be conducted to determine the effect of alternative, non-symmetrical error distributions. The results of this study may not be generalizable beyond even distributions of monetary error into affected months.

#### Generalizability of results

The results of this study should be generalizable to other medium-sized manufacturing firms with have relatively few product lines. The type I and type II error rates are expected to vary when different financial data is analyzed, but the relative performance of the alternative analytical techniques should remain consistent. Extension of these results out of the manufacturing industry or to different economic conditions is not recommended without further analysis.

## CHAPTER VII

### CONCLUSIONS AND RECOMMENDATIONS

#### Summary of Research Approach

##### Problem investigated

The research question pursued in this study addressed the relative reliability of alternative analytical review procedures used in auditing. Three ways were suggested for applying analytical review procedures in an auditing context: (a) financial statement analysis to determine the current financial health and to predict the future financial health of an enterprise, (b) directing attention to unusual fluctuations in the financial statement data which could result from material monetary errors, and (c) application as substantive tests to provide evidential matter concerning the fairness of the financial statements. Little empirical research has been performed concerning the reliability of analytical review procedures applied for these purposes. This study was oriented toward the purposes of attention directing and substantive testing within medium-sized manufacturing firms.

##### Method used

A simulation process was used to evaluate the reliability of alternative analytical review procedures. Information concerning the nature of analytical review procedures and monetary errors was

required to establish the control parameters for the simulation model. Actual financial data from representative medium-sized manufacturing firms was needed to develop a financial data base.

For analytical review procedures, information was needed which defined the analytical techniques typically applied during an audit, the financial relationships to which they were applied, and the decision rules used to identify significant fluctuations. Information concerning the nature of monetary errors addressed the likelihood of a potential source of monetary error resulting in a material error in the financial statement balances, and the distribution of the error across the monthly accounts. Information concerning the largest expected size of the resulting monetary errors was also needed.

The specific information required for the simulation model was gathered using a Delphi-like method involving an estimate-feedback-estimate process. The sample consisted of thirteen practicing auditors who were considered experts in the manufacturing industry. Personal interviews were used to collect the initial estimates, while a questionnaire was developed to provide the feedback and assess the followup estimates.

This specific information was integrated into the simulation model. Two overlapping sets of financial data were collected for each of two firms. Practicing auditors identified the firms as representative of the manufacturing industry. The simulation model was applied to these financial data sets to provide information concerning the number of type I and type II errors which result from applying each of the alternative analytical procedures across varying conditions of error size and error distribution.

When the monetary error is less than a material amount, the type I error rate is derived by dividing the number of months in

which investigations are signalled by the total number of months evaluated. When the monetary error equals or exceeds a material amount, the type II error rate is derived by dividing the number of months in which investigations are not signalled by the total number of months investigated.

#### Nature of analysis

The simulation results were analyzed descriptively using parametric statistics. Nonparametric tests were applied to the results to identify any significant differences in the error rates associated with alternative levels of the control treatments. Parametric statistics were used to assess the direction of any trends, and the relative significance of the treatment effects.

#### Results and Conclusions

The information assessed from the practicing auditors indicates a high degree of consensus on the type of analytical procedures that are typically applied during an audit of a medium-sized manufacturing firm. There was also agreement on the potential sources of monetary error which are more likely to result in material errors within the financial statements. The associations between the potential monetary error sources and the financial relationships affected by the resulting errors are presented in Appendix E.

With respect to the distribution of the monetary errors across the monthly account balances, the participants expect fifty percent of the cutoff errors to occur at the end of interim periods. The remaining cutoff errors tend to be either systematic or occur with no specific pattern. Point-in-time tests applied at interim or end-of-period cutoff points will not detect a cutoff

error unless the error occurs at the cutoff point. Hence, point-in-time tests are not effective in detecting cutoff errors.

The analytic tests evaluated in this study produced statistically different error rates when applied to different firms. However, application of the analytic tests to two consecutive time periods within each firm did not significantly alter the associated type I and type II error rates. This result support the audit practice of using the prior period's audit program and results as a reference point for audit planning for the current audit period.

Although the error rates for the analytic test change from one firm to the next, the relative performance of the analytic tests does not. Thus, the analytic test which performed best overall in firm A also performed best overall in firm B. If the relative performance of the analytic tests remains concordant across other medium-sized manufacturing firms, then a minimal set of analytical review procedures may be developed which should provide the best audit evidence available from analytical review. The auditor must use caution in applying such a minimal set to ensure that the specified effectiveness levels are met.

The effectiveness of financial ratio analysis appears to be sensitive to the current economic environment of the firm. The economic conditions reflected in the data evaluated in this study are that costs are increasing at a higher rate than revenues. The ratios evaluated within this study were more sensitive to understatement errors and less sensitive to overstatement errors. These results suggest the effects of overstatement errors cannot be assumed equivalent to the effects of understatement errors. Additionally, auditors should incorporate both seasonal and economic trends in the client's business activities into the

analytical review procedures applied during the audit.

A difference exists in the sensitivity of analytic tests applied on a monthly basis or at a point-in-time to the error size and error distribution treatments. The effects on analytic tests applied at each cutoff point are discussed separately.

With respect to analytic tests applied on a monthly basis, the size of the monetary error seeded into the financial statement accounts does not significantly influence the type I and type II error rates. There is a slight tendency for the analytic tests to be less efficient and more effective as the size of the error increased. But in general, the analytical procedures tend to signal investigations based on the normal fluctuations within the data.

This suggests that analytical review procedures applied on a monthly basis are not effective when applied as substantive tests. There is little assurance that there is not a material error in a month not signalled for investigation.

The distribution of the monetary error into the financial accounts does produce a trend in the type I and type II error rates associated with analytic tests which apply materiality-based or statistical decision rules on a monthly basis. As the distribution of the error becomes more disperse, the number of type I errors increases while the number of type II errors decreases. This trend is explained by the procedure of adjusting the comparison criterion for the number of months investigated. As multiple months are each investigated for monetary errors which are less than a material amount, the comparison threshold which signals an investigation is lowered. Hence, the techniques become more sensitive to normal fluctuations in the financial data, signalling additional fluctuations.

The nature of the simulation process, coupled with this increased sensitivity to the distribution of the monetary error, produces the trend in the error rates. If a material error was not seeded, searching for a more disperse error signals additional investigations thereby increasing the type I error rate. If a material errors was seeded, search for a more disperse error signals additional investigations thereby decreasing the type II error rate. This implies that auditors should not apply analytical review procedures to search for systematic errors unless material systematic errors are considered likely.

The use of monthly data for analytical tests tends to provide more consistent results across financial data sets. Although the type I and type II error rates are expected to vary, the relative performance of the analytical procedure applied to the financial relationship appears to remain concordant. The need for monthly data should not present a problem for most audit situations. Firms which use electronic data processing to maintain their accounting systems should be able to generate monthly financial statements. Firms with manual systems can also produce the required information from the general ledger. If structural models are applied, four years of monthly data must be generated. However, if traditional techniques are applied, then monthly data is only required for the current and previous audit period.

In this study, analytic tests were applied at a point-in-time to detect errors seeded into monthly financial balances. Since the point-in-time tests evaluate the cumulative balances at the point-in-time, there is very little sensitivity to the distribution of the monetary error. The analytic tests applied at a point-in-time do show an increasing trend in the number of investigations signalled at the size of the monetary error increases. But, in

general, point-in-time tests are not considered sensitive to the size of the monetary error.

In most situations, the analytical review procedures applied at a point-in-time to detect monthly errors were found to be unreliable. Approximately forty percent of the potential sources of monetary error produce temporary (cutoff) errors in the financial balances. Point-in-time tests will not detect temporary errors unless applied to the month that contains the error. It was necessary to evaluate the ability of analytical review procedures applied at a point-in-time to detect permanent errors.

Analytical review procedures applied at a point-in-time to detect permanent errors were also found to be unreliable. An analytic test applied to a specific financial relationship tends to signal all months evaluated for investigation or no months evaluated for investigation, depending on whether the actual cumulative balance is outside or within the precision interval for the analytic test.

Point-in-time tests should be applied to signal financial accounts for investigation within the audit period. They are not designed to indicate the months which should be investigated. No general conclusions can be drawn from the results of this study concerning the effectiveness of the point-in-time tests in signalling materially misstated financial accounts for investigation.

The judgemental and statistical decision rules evaluated in this study are sensitive to varying levels of precision. There are basically two forms of precision which are used in this study. The first is based on a materiality threshold which is allocated to each individual account. The second form of precision involves a percentage change in the balances; specifically, plus or minus ten

percent. When decision rules incorporate tight precision intervals, the analytic tests which incorporate judgemental and statistical decision rules are associated with higher type I error rates and lower type II error rates. Materiality-based decision rules do not explicitly incorporate precision.

In summary, the results of this study suggest that the analytical review procedures are more sensitive to the distribution of the monetary error than the size of the monetary error. Eighty-two percent of the actual financial account balances were outside of the precision interval associated with the analytic test prior to the introduction of monetary error. This suggests that: (a) the analytical review procedures do not perform well in predicting the account balances or (b) the precision interval associated with the decision rules is too tight and/or the method of allocating materiality is too restrictive.

For analytic tests applied on a monthly basis, there was very little variation among the percentages of actual financial balances initially outside of the precision interval (plus or minus seven percent). The predictive ability of the regression-based techniques was higher than the other techniques. If seasonal trends were the cause of the poor predictive ability, the traditional analytic tests (based on a martingale process) should perform better than the simple linear regression model. Economic patterns in the financial data do not explain the poor predictive ability of the analytic tests. This tends to suggest that the precision intervals were too tight.

The analytic tests which used precision in terms of materiality (materiality-based and statistical) were consistently less efficient and more effective than the analytic tests which used precision in terms of a percentage change (traditional).

Hence, the method of allocating materiality may be too restrictive. Additional research is necessary to determine which method of allocating materiality and what percentage intervals tend to provide the most reliable analytical review procedures. It is highly recommended that this research evaluates the performance of analytical review procedures applied to actual financial data.

#### Development of Selection Guidelines

Specific analytic tests appeared to be consistently more reliable over certain sets of financial relationships. These analytic tests were combined with the financial relationships to form recommended analytical review procedures. These procedures are summarized in the selection guidelines, Table 33, presented in Chapter 5.

The selection guidelines show the associations between the 33 potential sources of error most likely to result in a material error in the financial balances and a minimum set of analytical review procedures. The minimum set of analytical review procedures provides coverage for 94 of the 106 potential sources of monetary identified in this study. Those sources not covered by the minimum set are listed in Table 34, and mostly comprise classification errors. The selection guidelines may also be applied to detect monetary error from a single source through the use of a triangulation process.<sup>1</sup>

The information contained in the selection guidelines may be applied to assess the design of the internal accounting control system. The errors listed in the selection guidelines are those considered most likely to result in material monetary errors in the

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<sup>1</sup>See Chapter 5 for a discussion of triangulation.

financial balances. Hence, the system of internal control should be designed to detect and prevent such errors before they enter the financial accounts.

The information concerning the potential sources of monetary error in Table 33 should be considered during audit planning. Table 33 presents those sources of monetary error which are considered most likely to result in material errors in the financial accounts of medium-sized manufacturing firms. Auditors should design the audit program to test for the presence of these errors.

#### Recommendations on the Use of Analytical Review Procedures

##### Directing attention to fluctuations

The results of this study indicate that analytical review procedures should be applied in an attention directing mode. The procedures are useful in identifying fluctuations in financial data. However, they are not effective in identifying the cause of the fluctuation. This deficiency is due to the multiple dependencies between potential sources of monetary error and the financial relationships analyzed.

It may be possible to apply a triangulation process to isolate the cause of a fluctuation. However, the effectiveness of such a procedure is not addressed in this study. It is an area for future research.

In general, analytical review procedures which utilize financial ratios exhibit a higher type I error rate than analytical review procedures which utilize individual accounts. Hence, they have an increased tendency to signal investigations based on normal fluctuations in the data. This suggests that analytical review

procedures which analyze individual accounts are preferred when the auditor's objective in applying the procedure is directing attention to fluctuations in the monthly financial balances.

When significant fluctuations are signalled by the analytical review procedures applied in an attention directing mode, the auditor must determine if the fluctuation represents the presence of an accounting error or irregularity, or is caused by changes in accounting principles, changes in business conditions, or unusual events. Further audit actions may include inquiries of management and extensions of the analytic model, if appropriate based on management's response. The results of management inquiries will increase the auditor's understanding of the client's business, and may explain other significant fluctuations which are identified. Extending audit work has a higher cost, but may be necessary if the fluctuation cannot be attributed to changes in accounting principles, changes in business conditions, or unusual events.

Note that further audit actions are also subject to type I and type II errors. As a result of management inquiries, the auditor may decide that the fluctuation resulted from normal business operations when, in fact, a material error exists in the financial accounts. The auditor may also extend audit work when no material errors are present in the financial account. Whenever audit work is extended, type I and type II errors may occur. Hence, the audit risk model is cyclic. The auditor may never be assured that no type I or type II errors have occurred.

This study did not address the costs of extending audit work as a result of a high type I error rate compared to the costs of performing detailed tests of transactions and balances. Hence, no general conclusions can be drawn concerning the cost effectiveness of analytical review procedures with high type I error rates.

### Substantive Testing

The results of this study indicate that the auditor should not rely totally on analytical review procedures for substantive testing. The analytic tests evaluated in this study are sensitive to the distribution of the monetary error. Assessments from auditors concerning the characteristics of monetary errors suggests that errors will tend to be distributed either systematically across the accounts or isolated within a few monthly balances. Thus, the auditor is concerned with detecting both systematic errors and errors that occur with not specific pattern.

If an analytical review procedure is applied to detect systematic errors when the actual risk of systematic errors is low, a high type I error rate will result. It is recommended that the auditor rely on detailed tests to guard against such systematic errors. This suggests that dual purpose tests or tests of transactions and balances should be conducted in addition to compliance tests. Each component of the audit risk model should be applied to some degree, implying that some form of direct tests of transactions should be conducted.

The analytical review procedures may be applied as a substantive test in support of recorded balances. In those circumstances where good internal systems exist and are complied with, analytical review techniques may lead to reduced audit cost while maintaining the necessary degree of assurance concerning the overall fairness of the financial statements.

Note that the type II error rates reported in this study are valid only for a single analytical review procedure applied to detect a monetary error from a single source. In actual practice, auditors will apply multiple analytical review procedures to detect

monetary errors. The overall type II error rate for detecting monetary errors from the single source will be lower than the individual type II error rates of the procedures applied. Since the analytical review procedures may be related, the statistical tests are not independent. The overall type II error rate cannot be derived unless the extent of the dependence between the statistical tests is known.

#### Recommendations for Future Research

The process developed in this study should be applied to financial data from additional firms within the manufacturing industry, and to firms outside of the manufacturing industry. Within the manufacturing industry, only financial data is required since it is assumed that the nature of monetary errors and form of analytical review procedures would remain the same. Application of the simulation process outside of the manufacturing industry requires assessment of the nature of errors and analytical procedures for those industries. This additional information would be useful in developing industry guidelines for analytical review. It would also provide insight on audit problems which are common among industries.

Other than expanding the scope of the study, some specific areas within the study which require further research were identified. These include:

- a. Determining the best method for incorporating seasonal and economic trends into analytical review procedures. This would include analysis of which economic indicators are readily available for auditors to use, and how the analytic tests should be adjusted to compensate for the identified trends.
- b. Analysis of whether analytical review procedures

can be relied upon to detect offsetting errors. A major limitation on the practicality of this study results from the assumption that offsetting errors do not occur. A theoretical question also needs to be addressed as to whether the financial statements are fairly presented if they include offsetting material errors.

c. Determining the reliability of analytical review procedures in detecting errors from related sources. Because this type of analysis will be searching for monetary errors that are less than a material amount, increased effectiveness but decreased efficiency of the analytic tests is expected. Decreasing the comparison thresholds for the decision rules to detect smaller errors will be analogous to reducing the thresholds for more disperse distributions of error.

d. Evaluating the behavior of the statistical decision rules to varying conditions where the underlying assumptions are not met. It is idealistic to assume that these assumptions are always met. Hence, the effects of not meeting the assumptions, and the sensitivity of the decision rule in such conditions, need to be analyzed.

e. Investigating the application of the triangulation method. It may be possible to develop combinations of analytical review procedures which may be applied to detect errors from a specific subset of the potential sources of monetary error.

f. Applying more sophisticated structural models. The inclusion of lagged variables in the regression model or the application of Box-Jenkins or indexed models may improve the predictive ability of the structural models.

g. Evaluating the behavior of other decision rules suggested by practicing auditors, as listed in Table 10.

h. Evaluating alternative methods of allocating

materiality to the individual accounts. The method used within this study appears too restrictive and resulted in precision intervals for the statistical and materiality-based analytical review procedures which are too tight.

## APPENDIX A

### THE EFFECT OF MONETARY ERROR SOURCES

This appendix describes the effects of the monetary error sources analyzed in this study on the financial accounts. The monetary error sources are categorized by major business cycle and the type of transaction.

#### Sales and Collection Cycle

##### Sales Transactions

1. Goods shipped but not invoiced.

This error would normally mean that the sale and related accounts receivable will be understated. If sales invoices are used to relieve perpetual inventory records, then inventory will be overstated.

2. Sales recorded but goods not shipped.

If unintentional, customers will complain about the missing shipment. If intentional, fictitious customers or related parties may have been charged for the goods. In both cases, the error would normally result in an overstatement of sales and accounts receivable. If sales invoices are used to relieve perpetual inventory records, then inventory will be understated.

3. Sales invoiced but not recorded.

This recording error would result in sales and accounts receivable being understated. If inventory is relieved when the sale is recorded, then inventory would be overstated.

4. Sales recorded before legal title passes.

This error would typically occur during consignments or contingent sales. Recording the sale before legal title passes would overstate sales and accounts receivable. We assume that the inventory would be relieved when the sale is recorded.

5. Invoice recorded incorrectly in the journal.

Sales and accounts receivable could be either understated or overstated.

6. Wrong prices used on invoice.

(a) If the prices are too high: If the customer pays anyway, there is no impact on the financial statements. If the customer refuses to pay, then sales and accounts receivable are overstated and a credit memorandum would be issued.

(b) If the prices are too low: The customer will probably pay without comment. Although the company has incurred losses due to under-pricing, the financial statements are fairly presented. If recoveries are possible, then sales and accounts receivables will be understated until the recovery is made.

7. Wrong quantity shown on shipping document and sales invoice.

(a) If the quantity actually shipped exceeds the amount shown as shipped and invoiced: The customer may pay the invoiced amount. If adjusted billings are possible, sales and accounts receivable are understated. If adjusted billings are not possible, then sales and accounts receivable are fairly presented but are not as high as they should be. In either case, perpetual inventory is overstated.

(b) If the quantity actually shipped is less than the amount billed: If the customer pays anyway, there is no impact on sales and accounts receivable, but inventory will be understated. If the customer recognizes the error and refuses to pay for the unshipped quantity, then sales and accounts receivable are overstated and a credit memorandum would be issued.

8. Wrong quantity shown on invoice; shipping document correct.

Although the error is made at a different point in the company system, the impact is the same as error #7.

9. Wrong extension of quantity and price on sales invoice.

(a) If the extension results in an overstatement of the sales invoice total: If the customer does not recognize the error and pays anyway, then sales and accounts receivable are not affected, but perpetual inventory would be understated. If the customer detects the error, then a correction would be requested before payment and a credit memorandum would be issued.

(b) If the extension results in an understatement of the sales invoice total: If the customer pays without comment and corrected billings are possible, then sales and accounts receivable are understated. If corrected billings are not possible, then the financial statements are fairly presented but sales are not as high as they should be. In both situations, perpetual inventory will be overstated.

10. Wrong period credited for sale.

(a) If sales were properly made in the current period but not recorded until the subsequent period, then current sales and accounts receivable will be understated. If the perpetual inventory is not relieved in the current period, then inventory will be overstated.

(b) If sales were properly made in the subsequent period but recorded in the current period, then sales and accounts receivable will be overstated. If the perpetual inventory was relieved in the current period, then inventory will be understated.

## 11. Sales classified erroneously as to type.

This error would not affect net income unless the gross profit method is used to determine ending inventories.

## 12. Unearned interest included as revenue.

Interest is not deducted in advance on receivables. Sales are overstated and unearned revenue is understated. In subsequent periods, interest revenues would be understated.

## 13. Incorrect recording of sales tax liability.

If the sales tax is understated, then accounts receivable are overstated and sales tax liability is understated, resulting in sales tax expense being understated. If the sales tax is overstated, then accounts receivable are understated and sales tax liability and expense are overstated.

## 14. Sales commissions erroneously recorded.

(a) If the sales commissions are understated: The employee would normally catch these errors and request correction. Thus, salaries payable and selling expense would be understated until corrected. If the employee does catch the error, then there is no impact on the financial statements.

(b) If the sales commissions are overstated: The employee probably would not report the error. If the company catches the error and adjustments are possible, then salaries payable and selling expenses are overstated until corrected. If adjustments are not possible, then the statements are fairly presented but selling expenses are higher than they should be.

## 15. Quoted price not used on invoice.

The impact is the same as error #6.

## 16. Duplicate shipments.

It is assumed that duplicate shipments would produce duplicate sales invoices. If the customer accepts the second shipment, then there is impact on the financial statements. If the customer does not accept the shipment, then sales and accounts receivable are overstated and inventory is understated until the credit memorandum is issued. Also, the company will incur additional transportation expenses.

## 17. Billing terms incorrect.

If an excessive discount is offered and an adjustment is not possible, then the financial statements are fairly presented but net sales are lower than they should be. Likewise, there is no financial statement impact if an insufficient discount is offered and the customer pays anyway. However, if an insufficient discount is offered and the customer requests correction prior to payment, then sales discounts are understated and accounts receivable are overstated until the adjustment is processed.

## 18. Billing of wrong customer.

It is assumed that the customer billed incorrectly would request correction and not provide payment. Thus, this error results in a delay in payment, but does not affect the financial statements.

### Sales Returns Transactions

#### 19. Goods returned; no credit given to customer.

If the customer pays the bill in full, then there is no error in the financial statements. If the customer withholds payment for the return, then accounts receivable is overstated and sales returns is understated until the credit memorandum is issued. (It is assumed that the returned goods are re-entered into the inventory system. See error #23 below.)

#### 20. Goods not returned, credit given to customer.

(a) If a credit memorandum is issued, then accounts receivable are understated, sales returns are overstated, and inventory is overstated.

(b) If a cash disbursement is made, then cash is understated and sales returns are overstated.

#### 21. Returns classified erroneously as to type of item.

If the gross profit method is used to value inventory, then net income may be affected. Otherwise, there is no impact to the financial statements.

#### 22. Credit given for goods never recorded as a sale.

Accounts receivable are understated, sales returns are overstated, and inventory is overstated.

#### 23. Goods returned but not re-entered into inventory system.

Inventory will be understated.

#### 24. Wrong quantity/price credited for returned goods.

(a) If quantity/price allowed is too high: (1) If the customer accepts the credit or adjustments are not possible, then the financial statements are fairly presented. (2) If adjustments are possible, then accounts receivable are understated, sales returns are overstated, and inventory is overstated.

(b) If quantity/price allowed is too low: If the customer pays the remaining bill then the financial statements are fairly presented. If the customer complains, then accounts receivable is overstated, sales returns is understated, and inventory is understated until the credit memorandum is issued.

#### 25. Error in extension on credit memorandum.

The impact is the same as error # 24.

#### 26. Wrong period credited for return.

(a) If the return was made in the current period but not

recorded until the subsequent period, then current accounts receivable will be overstated, sales returns will be understated, and inventory will be understated.

(b) If the return was made in the subsequent period and recorded in the current period, then current accounts receivable will be understated, sales returns will be overstated, and inventory will be overstated.

27. Wrong items credited for return.

This error would typically result in an incorrect valuation of the amount of credit. The impact is to understate (overstate) accounts receivable and overstate (understate) sales returns and inventory accounts.

Sales Allowances Transactions

28. Sales allowance granted but not recorded.

Accounts receivable is overstated and sales allowances is understated.

29. Wrong period credited for allowance.

(a) If the allowance was made in the current period but not recorded until the subsequent period, then accounts receivable will be overstated and sales allowances will be understated.

(b) If the allowance was made in the subsequent period but recorded in the current period, then accounts receivable will be understated and sales allowances will be overstated.

30. Sales allowance incorrectly valued.

(a) If the allowance is too high and the customer accepts the allowance, then accounts receivable is understated and sales allowances is overstated. (Assuming adjustments are possible.)

(b) If the allowance is too low: If the customer pays the remaining bill, then the financial statements are fairly presented. If the customer requires an adjustment, then accounts receivable is overstated and sales allowances is understated until the adjustment is made.

Cash Receipts Transactions

31. Cash not deposited or recorded.

Accounts receivable will be overstated and cash will be understated.

32. Cash recorded but not deposited.

Cash will be overstated. In the event of an error, the statements will not balance. In the event of an irregularity, a compensating error must be introduced by understating accounts receivable or some expense.

33. Cash deposited but not recorded.

Accounts receivable will be overstated and cash will be

understated. Note that the cash account will not reconcile with the bank statement.

34. Cash amount recorded incorrectly.

This could result in an understatement of accounts receivable and an overstatement of cash, or vice versa.

35. Cash credited to wrong sub-account.

This will cause individual customer balances to be misstated, but will not directly impact the financial statements.

36. Cash recorded in wrong period.

(a) If cash is received in the current period but recorded in a subsequent period, then accounts receivable is overstated and cash is understated.

(b) If cash is received in the subsequent period but recorded in the current period, then accounts receivable is understated and cash is overstated.

37. Improper recording of interest collected on interest bearing accounts.

This could result in an understatement of cash and interest revenues, or vice versa.

Bad Debt Write-off Transactions

38. Collectible accounts written-off.

Accounts receivable is understated and bad debt expense is overstated.

39. Uncollectible accounts not written-off.

Accounts receivable is overstated and the allowance for bad debts is overstated. If additional provisions are necessary, then the bad debt expense is understated.

40. Recoveries not recorded.

Cash is understated and bad debts expense is overstated.

Factoring or Assigning Transactions

41. Sale or assignment of receivables not recorded.

Accounts receivable are overstated and cash is understated. If the cash was deposited, then a bank reconciliation error will result.

42. Cash proceeds from sale or assignment not deposited.

Cash will be overstated and a bank reconciliation error will result.

### Other Transactions

43. Failure to provide adequate product warranty liability.

Both the warranty expense and the estimated liability for product warranties are understated.

### Acquisition and Payment Cycle

### Purchases Transactions

44. Liability incurred but not recorded.

Accounts payable will be understated along with the related asset or expense. If the transaction involves materials purchases, then materials inventory will be understated.

45. Purchases recorded but goods not received.

Accounts payable and the related account (asset or service) will be overstated.

46. Purchases incorrectly valued.

Accounts payable and the related account (asset or service) could be overstated or understated.

47. Purchases incorrectly classified.

This would result in a mis-statement of the individual accounts affected, but would not have an overall effect on the financial statements unless the gross profit method is used to value the inventories.

48. Purchases recorded in wrong period.

If the liability is incurred in the current period but recorded in the subsequent period, then accounts payable and the related accounts are understated. If the liability is incurred in the subsequent period but recorded in the current period, then accounts payable and the related account are overstated.

### Purchases Returns and Allowances Transactions

49. Goods returned but no credit received.

Accounts payable is overstated and purchases returns is understated.

50. Credit received but goods not returned.

Accounts payable is understated and purchase returns is overstated.

51. Wrong quantity/price credited for returned goods.

If the error is discovered, then accounts payable is overstated (understated) and purchases returns is understated (overstated) when the amount of credit is too low (high). If the error is not discovered and the erroneous amount is paid, then the financial statements are fairly stated.

52. Wrong period credited for return.

If the credit is received in the current period and recorded in a subsequent period, then accounts payable is overstated and purchases returns is understated. If the credit is received in a subsequent period and recorded in the current period, then accounts payable is understated and purchases returns is overstated.

#### Receipt of Goods Transactions

53. Damaged or missing goods not reported.

Accounts payable and the related inventory accounts are overstated.

#### Cash Disbursements Transaction

54. Payments recorded but not made.

Understate liabilities and cash.

55. Payments made but not recorded.

Overstate liabilities and cash.

56. Payment amounts recorded incorrectly.

Mis-state liabilities and cash, with both either overstated or understated.

57. Payments based on incorrect terms or price.

If the valuation is too low, then the liabilities and cash are understated. If the valuation is too high, then the liabilities and cash are overstated.

58. Payments recorded in wrong period.

If the payment is made in the current period but not recorded until the subsequent period, then liabilities and cash are overstated. If the payment is recorded in the current period but not made until the subsequent period, then the liabilities and cash are understated.

59. Diversion of payments.

Liabilities are understated.

60. Duplicate payments.

Overstate liabilities and cash (assuming that the first payment was not recorded.)

61. Payment for cancelled orders.

Overstate liabilities and cash.

#### Prepayments Transactions

62. Prepayments are incorrectly valued.

If the valuation is too high, then prepayments are overstated and cash is understated. If the valuation is too low, then prepayments are understated and cash is overstated.

63. Related Expenses are not properly classified.

This would result in mis-classification among the expense accounts and should not affect net income.

64. Prepayments are recorded in wrong period.

If payment is made in the current period and recorded in a subsequent period, then prepayments are understated and cash is overstated. If payment is made in a subsequent period and recorded in the current period, then prepayments are overstated and cash is understated.

65. Prepaid items not listed as prepaid.

Prepayments are understated, related expenses are overstated.

66. Items are listed as prepaid that are not prepaid.

Prepayments are overstated, related expenses are understated.

#### Accruals Transactions

67. Failure to include items that should be accrued.

The accrued expense and related expense in the current period are both understated.

68. Accrual of items that should not be accrued.

The accrued expense and related expense in the current period are both overstated.

69. Accruals incorrectly valued.

If the valuation is too low, then accrued expenses and related expenses are both understated. If the valuation is too high, then accrued expenses and related expenses are both overstated.

70. Accruals recorded in wrong period.

If the expense is incurred in the current period and recorded in a subsequent period, then accrued expenses and related expenses are both understated. If the expense is recorded in the current period and incurred in the subsequent period, then accrued expenses and related expenses are both overstated.

71. Related expenses are not properly classified.

This would result in mis-classification among the expenses and should not affect net income.

### Payroll and Personnel Cycle

#### Payroll Transactions

72. Employees paid for work not performed.

Both the payroll expense account and the accrued expense account would be overstated.

73. Employee wages calculated using wrong hourly rate.

If the valuation is too low, then the payroll expense and accrued expense would be understated until the adjustment is processed. (assuming the employee catches the error and requests adjustment.) If the valuation is too high and adjustments are possible, then the payroll expense and accrued expense would be overstated until the adjustment is processed.

74. Employees not paid for hours worked or production completed.

Assuming an adjustment is requested, the payroll expense and accrued expense will be understated.

75. Overtime or shift differential hours not recognized.

Assuming an adjustment is requested, the payroll expense and accrued expense will be understated.

76. Employees paid for unauthorized vacation/sick time.

If adjustments are possible, then payroll expenses and accrued expenses are overstated.

77. Misappropriation of unclaimed wages.

If the misappropriated wages cannot be recovered, then a liability to the original employee still exists. Payroll expenses and accrued expenses are understated.

78. Mathematical errors in the calculation of payroll.

The impact is the same as for error #73.

79. Erroneous recording/classification of compensation.

This would result in incorrect valuations among the payroll expense accounts, but should not affect net income.

80. Incorrect handling of end-of-period accruals.

If the payroll expenses is incurred in the current period and recorded in a subsequent period, then payroll expenses and accrued expenses are understated. If the payroll expenses are recorded in the current period and incurred in subsequent periods, then payroll expenses and accrued expenses are overstated.

81. Expense reimbursement inaccurately calculated.

If the valuation is too low and the employee requests adjustment, then payroll expenses and accrued expenses are understated. If the valuation is too high and adjustment is possible, then payroll expenses and accrued expenses are overstated.

Allocation of Labor Transactions

82. Hourly costs of direct labor incorrectly valued.

If valuation is too low (high), then accrued payroll expense and work-in-process are understated (overstated).

83. Hours required to manufacture a unit recorded incorrectly.

Same as error #82.

84. Labor performed but not correctly allocated.

Incorrect valuation among the jobs/processes, but no impact on net income.

85. Wages/salaries improperly classified.

Result in valuation errors among work-in-process, factory overhead, selling expenses, and administrative expenses.

Inventory and Warehousing Cycle

Storage Transactions

86. Obsolescent items maintained in inventory.

Inventory overstated, obsolescence expense understated.

87. Consigned out items are double counted in inventory.

Ending inventory overstated.

88. Consigned in items are counted in inventory.

Ending inventory overstated.

Raw Material to Work-In-Process  
Transactions

89. Material requisitions not recorded.

Raw materials inventory overstated, work-in-process inventory is understated.

90. Material requisitions are incorrectly recorded.

Raw materials inventory overstated (understated), work-in-process inventory understated (overstated).

91. Material requisitions recorded in wrong period.

If materials used in current period and recorded in subsequent period, then raw materials inventory is overstated and work-in-process inventory is understated. If materials recorded in current period and used in subsequent period, then raw materials inventory is understated and work-in-process inventory is overstated.

92. Materials requisitions incorrectly classified.

Incorrect valuation among raw materials items. Should not impact net income.

Work-In-Process to Finished Goods  
Transactions

93. Costs of materials, labor and overhead incorrectly recorded.

If the recorded value is too low (high), then work-in-process is overstated (understated) and either materials inventory, payroll expenses, or factory overhead are understated (overstated).

94. Costs of materials, labor and overhead are incorrectly valued.

If valuation is too high (low), then work-in-process is understated (overstated) and either materials inventory, payroll expenses, or factory overhead is overstated (understated).

95. Costs of materials, labor and overhead are incorrectly classified.

Assuming that classification errors are within the respective accounts, there will be no net effect on income.

96. Record costs of materials, labor or overhead in wrong period.

(a) If costs are incurred in the current period and recorded in subsequent period, then work-in-process will be understated and either materials inventory, accrued expenses, or factory overhead will be overstated.

(b) If costs are recorded in current period and incurred in a subsequent period, then work-in-process will be overstated and either materials inventory, accrued expenses or factory overhead will be understated.

98. Incorrect quantity transferred to finished goods.

Work-in-process is overstated (understated) and finished goods is understated (overstated).

99. Finished goods not recorded.

Work-in-process is overstated and finished goods is understated.

100. Finished goods recorded at incorrect value.

Same as error #97.

101. Finished goods recorded in wrong period.

If production completed in current period and recorded in subsequent period, then work-in-process is overstated and finished goods is understated. If recorded in current period and production completed in subsequent period, then work-in-process is understated and finished goods are overstated.

#### Shipments Transactions

102. Quantity shipped does not agree with quantity ordered.

Finished goods are overstated (understated) and cost of goods sold is overstated (understated)

103. Goods shipped different from goods ordered.

Valuation errors among the finished goods inventories, and increased transportation expenses of retrieve invalid shipments.

104. Goods shipped to fictitious customer.

Sales are overstated, accounts receivable are overstated.

105. Goods shipped to wrong party.

Firm must incur additional expenses of shipping and returning goods.

106. Goods shipped too early or too late.

In addition to contractual penalties which will increase miscellaneous expenses, the goods may not be accepted resulting in additional inventory expenses.

APPENDIX B  
AFFECTED ACCOUNT SETS

Monetary error sources can influence the financial balances in numerous financial accounts. This appendix groups the affected financial accounts by logical relationships. Each relationship defines a unique set of financial accounts that are affected by one or more monetary error sources. These logical relationships are termed "affected account sets."

The affected account sets included in this appendix are numbered in multiples of 10 (e.g., 10, 50, 120, 340, etc.). Subsets are formed from the affected financial accounts and the duration and direction of the monetary error. There are four possible combinations of duration and direction for each affected account set. The four subsets are identified by the least significant digit of the subset code; for example, 11 identifies subset one of affected account set ten.

For each subset, the sources of monetary error are listed which could result in a monetary error in the specified financial accounts (in the direction and for the duration specified).

For each affected account set, the financial relationships are listed which are either directly or indirectly affected by the resulting monetary errors.

## Affected Account Set # 10

Account Subset - 11  
Understate Gross Sales  
Understate Accounts Receivable

## Error sources

1 :Goods shipped but not invoiced  
3 :Sales invoiced but not recorded  
5 :Invoice recorded incorrectly in journal

Account Subset - 12  
Overstate Gross Sales  
Overstate Accounts Receivable

## Error sources

2 :Sales recorded but goods not shipped  
5 :Invoice recorded incorrectly in journal  
104 :Goods shipped to fictitious customer

Account Subset - 13  
Understate Gross Sales  
Understate Accounts Receivable  
Delay for 1 month, then process Affected Account Subset 81

## Error sources

6 :Wrong prices used on invoice  
7 :Wrong quantity shown on shipping document and sales invoice  
8 :Wrong quantity shown on invoice; shipping document correct  
9 :Wrong extension of quantity and price on sales invoice  
15 :Quoted price not used on invoice

Account Subset - 14  
Overstate Gross Sales  
Overstate Accounts Receivable  
Delay for 1 month, then process Affected Account Subset 82

## Error sources

6 :Wrong prices used on invoice  
7 :Wrong quantity shown on shipping document and sales invoice  
8 :Wrong quantity shown on invoice; shipping document correct  
9 :Wrong extension of quantity and price on sales invoice  
15 :Quoted price not used on invoice

## Financial Relationships Affected by Affected Account Set 10

Gross Margin Percentage  
 Net Sales / Total Assets  
 Net Sales / Physical Production Volume  
 Sales Discounts / Gross Sales  
 Sales Returns and Allowances / Gross Sales  
 Sales Commissions / Net Sales  
 Sales Taxes / Gross Sales  
 Receivables Turnover  
 Number of days sales in accounts receivable  
 Change in cash / Change in receivables  
 Allowance for Bad Debts / Receivables  
 Retained Earnings / Net Income after Tax plus Dividends  
 Bad Debts Expense / Net Sales  
 Product Warranty Expense / Net Sales  
 Sales Expense / Gross Sales  
 Bonuses / Pre-tax Profit  
 Current Ratio  
 Quick Ratio  
 Inventory / Current Assets  
 Income from Operations / Tangible Assets  
 Income from Operations / Net Sales  
 Profit to Equity  
 Net Sales  
 Gross Profit  
 Receivables  
 Working Capital

## Affected Account Set # 20

## Account Subset - 21

Overstate Finished Goods Inventory  
 Understate Cost of Goods Sold

## Error sources

1 :Goods shipped but not invoiced  
 3 :Sales invoiced but not recorded  
 7 :Wrong quantity shown on shipping document and sales invoice  
 8 :Wrong quantity shown on invoice; shipping document correct  
 9 :Wrong extension of quantity and price on sales invoice  
 20 :Goods not returned; credit given to customer  
 21 :Returns classified erroneously as to type of sale  
 22 :Credit given for goods never recorded as a sale  
 27 :Wrong items credited for return

## Account Subset - 22

Understate Finished Goods Inventory  
 Overstate Cost of Goods Sold

## Error sources

2 :Sales recorded but goods not shipped  
 7 :Wrong quantity shown on shipping document and sales invoice  
 8 :Wrong quantity shown on invoice; shipping document correct  
 9 :Wrong extension of quantity and price on sales invoice  
 23 :Goods returned but not reentered into inventory system  
 27 :Wrong items credited for return

## Account Subset - 23

Overstate Finished Goods Inventory

Understate Cost of Goods Sold

Delay for 1 month, then process Affected Account Subset 22

## Error sources

- 10 :Wrong period credited for sale
- 24 :Wrong quantity/price credited for returned goods
- 25 :Error in extension on credit memorandum
- 26 :Wrong period credited for return
- 102 :Quantity shipped does not agree with quantity ordered

## Account Subset - 24

Understate Finished Goods Inventory

Overstate Cost of Goods Sold

Delay for 1 month, then process Affected Account Subset 21

## Error sources

- 10 :Wrong period credited for sale
- 16 :Duplicate shipments
- 24 :Wrong quantity/price credited for returned goods
- 25 :Error in extension on credit memorandum
- 26 :Wrong period credited for return

## Financial Relationships Affected by Affected Account Set 20

Direct Materials / Cost of Sales

Direct Labor / Cost of Sales

Factory Overhead / Cost of Sales

Finished Goods Turnover

Number of Days Sales in Finished Goods Inventory

Retained Earnings / Net Income after Tax plus Dividends

Bonuses / Pre-tax Profit

Current Ratio

Inventory / Current Assets

Income from Operations / Tangible Assets

Income from Operations / Net Sales

Profit to Equity

Cost of Sales

Gross Profit

Inventory Accounts

Working Capital

## Affected Account Set # 30

Account Subset - 31

Overstate Gross Sales

Understate Unearned Revenue

Delay for 1 month, then process Affected Account Subset 41

Error sources

12 :Unearned interest included as revenue

## Financial Relationships Affected by Affected Account Set 30

Gross Margin Percentage

Net Sales / Total Assets

Net Sales / Physical Production Volume

Sales Discounts / Gross Sales

Sales Returns and Allowances / Gross Sales

Sales Commissions / Net Sales

Sales Taxes / Gross Sales

Receivables Turnover

Number of days sales in accounts receivable

Retained Earnings / Net Income after Tax plus Dividends

Bad Debts Expense / Net Sales

Product Warranty Expense / Net Sales

Sales Expense / Gross Sales

Bonuses / Pre-tax Profit

Income from Operations / Tangible Assets

Income from Operations / Net Sales

Profit to Equity

Net Sales

Gross Profit

## Affected Account Set # 40

Account Subset - 41

Understate Interest Revenue

Error sources

37 :Improper recording of interest collected on receivables

Account Subset - 42

Overstate Interest Revenue

Error sources

37 :Improper recording of interest collected on receivables

## Financial Relationships Affected by Affected Account Set 40

Retained Earnings / Net Income after Tax plus Dividends

Bonuses / Pre-tax Profit

Profit to Equity

## Affected Account Set # 50

Account Subset - 51  
 Overstate Accounts Receivable  
 Understate Sales Tax Expense

Error sources  
 13 :Incorrect recording of sales tax liability

Account Subset - 52  
 Understate Accounts Receivable  
 Overstate Sales Tax Expense

Error sources  
 13 :Incorrect recording of sales tax liability

## Financial Relationships Affected by Affected Account Set 50

Net Sales / Total Assets  
 Sales Taxes / Gross Sales  
 Receivables Turnover  
 Number of days sales in accounts receivable  
 Change in cash / Change in receivables  
 Allowance for Bad Debts / Receivables  
 Retained Earnings / Net Income after Tax plus Dividends  
 Bonuses / Pre-tax Profit  
 Current Ratio  
 Quick Ratio  
 Inventory / Current Assets  
 Income from Operations / Tangible Assets  
 Profit to Equity  
 Expense Accounts  
 Receivables  
 Working Capital

## Affected Account Set # 60

Account Subset - 61  
 Understate Accrued Payroll Expense  
 Understate Sales Salary Expense  
 Delay for 1 month, then process Affected Account Subset 64

Error sources  
 14 :Sales commission erroneously recorded

Account Subset - 62  
 Overstate Accrued Payroll Expense  
 Overstate Sales Salary Expense  
 Delay for 1 month, then process Affected Account Subset 63

Error sources  
 14 :Sales commission erroneously recorded

Account Subset - 63  
 Understate Accrued Payroll Expense  
 Understate Sales Salary Expense

Error sources  
 None specified

Account Subset - 64  
 Overstate Accrued Payroll Expense  
 Overstate Sales Salary Expense

Error sources  
 None specified

Financial Relationships Affected by Affected Account Cet 60  
 Retained Earnings / Net Income after Tax plus Dividends  
 Sales Expense / Gross Sales  
 Bonuses / Pre-tax Profit  
 Current Ratio  
 Quick Ratio  
 Income from Operations / Tangible Assets  
 Income from Operations / Net Sales  
 Debt to Equity  
 Profit to Equity  
 Selling Expenses  
 Accrued Liabilities

Affected Account Set # 70

Account Subset - 71  
 Understate Sales Discounts  
 Overstate Accounts Receivable

Error sources  
 None specified

Account Subset - 72  
 Overstate Sales Discounts  
 Understate Accounts Receivable

Error sources  
 None specified

Account Subset - 73  
 Understate Sales Discounts  
 Overstate Accounts Receivable  
 Delay for 1 month, then process Affected Account Subset 72

Error sources  
 17 :Billing terms incorrect

Account Subset - 74  
 Overstate Sales Discounts  
 Understate Accounts Receivable  
 Delay for 1 month, then process Affected Account Subset 71

Error sources  
 17 :Billing terms incorrect

Financial Relationships Affected by Affected Account Set 70  
 Gross Margin Percentage  
 Net Sales / Total Assets  
 Net Sales / Physical Production Volume  
 Sales Discounts / Gross Sales  
 Sales Commissions / Net Sales  
 Receivables Turnover  
 Number of days sales in accounts receivable  
 Change in cash / Change in receivables  
 Allowance for Bad Debts / Receivables  
 Retained Earnings / Net Income after Tax plus Dividends  
 Bad Debts Expense / Net Sales  
 Product Warranty Expense / Net Sales  
 Bonuses / Pre-tax Profit  
 Current Ratio  
 Quick Ratio  
 Inventory / Current Assets  
 Income from Operations / Tangible Assets  
 Income from Operations / Net Sales  
 Profit to Equity  
 Net Sales  
 Gross Profit  
 Receivables  
 Working Capital

Affected Account Set # 80

Account Subset - 81  
 Understate Sales Returns & Allowances  
 Overstate Accounts Receivable

Error sources  
 None specified

Account Subset - 82  
 Overstate Sales Returns & Allowances  
 Understate Accounts Receivable

Error sources  
 20 :Goods not returned; credit given to customer  
 22 :Credit given for goods never recorded as a sale  
 27 :Wrong items credited for return  
 28 :Allowance granted but not recorded

## Account Subset - 83

Understate Sales Returns &amp; Allowances

Overstate Accounts Receivable

Delay for 1 month, then process Affected Account Subset 82

## Error sources

- 19 :Goods returned; no credit given to customer
- 24 :Wrong quantity/price credited for returned goods
- 25 :Error in extension on credit memorandum
- 26 :Wrong period credited for return
- 29 :Wrong period credited for allowance
- 30 :Sales allowance incorrectly valued

## Account Subset - 84

Overstate Sales Returns &amp; Allowances

Understate Accounts Receivable

Delay for 1 month, then process Affected Account Subset 81

## Error sources

- 24 :Wrong quantity/price credited for returned goods
- 25 :Error in extension on credit memorandum
- 26 :Wrong period credited for return
- 29 :Wrong period credited for allowance

## Financial Relationships Affected by Affected Account Set 80

Gross Margin Percentage

Net Sales / Total Assets

Net Sales / Physical Production Volume

Sales Returns and Allowances / Gross Sales

Sales Commissions / Net Sales

Receivables Turnover

Number of days sales in accounts receivable

Change in cash / Change in receivables

Allowance for Bad Debts / Receivables

Retained Earnings / Net Income after Tax plus Dividends

Bad Debts Expense / Net Sales

Product Warranty Expense / Net Sales

Bonuses / Pre-tax Profit

Current Ratio

Quick Ratio

Inventory / Current Assets

Income from Operations / Tangible Assets

Income from Operations / Net Sales

Profit to Equity

Net Sales

Gross Profit

Receivables

Working Capital

## Affected Account Set # 90

Account Subset - 91  
Understate Sales Returns & Allowances  
Overstate Cash

Error sources  
None specified

Account Subset - 92  
Overstate Sales Returns & Allowances  
Understate Cash

Error sources  
20 :Goods not returned; credit given to customer

Account Subset - 93  
Understate Sales Returns & Allowances  
Overstate Cash  
Delay for 1 month, then process Affected Account Subset 92

Error sources  
26 :Wrong period credited for return  
29 :Wrong period credited for allowance

Account Subset - 94  
Overstate Sales Returns & Allowances  
Understate Cash  
Delay for 1 month, then process Affected Account Subset 91

Error sources  
26 :Wrong period credited for return  
29 :Wrong period credited for allowance

## Financial Relationships Affected by Affected Account Set 90

Gross Margin Percentage  
 Net Sales / Total Assets  
 Net Sales / Physical Production Volume  
 Sales Returns and Allowances / Gross Sales  
 Sales Commissions / Net Sales  
 Receivables Turnover  
 Number of days sales in accounts receivable  
 Change in cash / Change in receivables  
 Retained Earnings / Net Income after Tax plus Dividends  
 Bad Debts Expense / Net Sales  
 Product Warranty Expense / Net Sales  
 Bonuses / Pre-tax Profit  
 Current Ratio  
 Quick Ratio  
 Inventory / Current Assets  
 Income from Operations / Tangible Assets  
 Income from Operations / Net Sales  
 Profit to Equity  
 Net Sales  
 Gross Profit

## Affected Account Set # 100

Account Subset - 101  
 Overstate Accounts Receivable  
 Understate Cash

## Error sources

31 :Cash not deposited or recorded  
 33 :Cash deposited but not recorded  
 34 :Cash amount recorded incorrectly  
 36 :Cash recorded in wrong period  
 41 :Sale or assignment of receivables not recorded

Account Subset - 102  
 Understate Accounts Receivable  
 Overstate Cash

## Error sources

32 :Cash recorded but not deposited  
 34 :Cash amount recorded incorrectly

Account Subset - 103  
 Overstate Accounts Receivable  
 Understate Cash  
 Delay for 1 month, then process Affected Account Subset 102

## Error sources

36 :Cash recorded in wrong period

## Account Subset - 104

Understate Accounts Receivable

Overstate Cash

Delay for 1 month, then process Affected Account Subset 101

## Error sources

36 :Cash recorded in wrong period

## Financial Relationships Affected by Affected Account Set 100

Net Sales / Total Assets

Receivables Turnover

Number of days sales in accounts receivable

Change in cash / Change in receivables

Allowance for Bad Debts / Receivables

Current Ratio

Quick Ratio

Inventory / Current Assets

Income from Operations / Tangible Assets

Receivables

Working Capital

## Affected Account Set # 110

## Account Subset - 111

Overstate Cash

## Error sources

32 :Cash recorded but not deposited

37 :Improper recording of interest collected on receivables

42 :Cash proceeds from sale or assignment not deposited

55 :Payment made but not recorded

56 :Payment amounts recorded incorrectly

57 :Payment based on incorrect terms or price

60 :Duplicate payments

61 :Payment for cancelled orders

## Account Subset - 112

Understate Cash

## Error sources

37 :Improper recording of interest collected on receivables

54 :Payments recorded but not made

56 :Payment amounts recorded incorrectly

57 :Payment based on incorrect terms or price

Account Subset - 113  
Overstate Cash  
Delay for 1 month, then process Affected Account Subset 112

Error sources  
58 :Payment recorded in wrong period

Account Subset - 114  
Understate Cash  
Delay for 1 month, then process Affected Account Subset 111

Error sources  
58 :Payment recorded in wrong period

Financial Relationships Affected by Affected Account Set 110  
Net Sales / Total Assets  
Change in cash / Change in receivables  
Current Ratio  
Quick Ratio  
Inventory / Current Assets  
Income from Operations / Tangible Assets  
Working Capital

Affected Account Set # 120

Account Subset - 121  
Understate Accounts Receivable  
Overstate Bad Debt Expense

Error sources  
38 :Collectible accounts written-off

Account Subset - 122  
Overstate Accounts Receivable  
Understate Bad Debt Expense

Error sources  
39 :Uncollectible accounts not written-off

## Financial Relationships Affected by Affected Account Set 120

Net Sales / Total Assets  
 Receivables Turnover  
 Number of days sales in accounts receivable  
 Change in cash / Change in receivables  
 Allowance for Bad Debts / Receivables  
 Bad Debts Expense / Net Sales  
 Bonuses / Pre-tax Profit  
 Current Ratio  
 Quick Ratio  
 Inventory / Current Assets  
 Income from Operations / Tangible Assets  
 Income from Operations / Net Sales  
 Profit to Equity  
 Bad Debt Expense  
 Receivables  
 Allowance for Bad Debts  
 Working Capital

## Affected Account Set # 130

Account Subset - 131  
   Overstate Accounts Receivable  
   Overstate Allowance for Bad Debts

Error sources  
   None specified

Account Subset - 132  
   Understate Accounts Receivable  
   Understate Allowance for Bad Debts

Error sources  
   None specified

## Financial Relationships Affected by Affected Account Set 130

Net Sales / Total Assets  
 Receivables Turnover  
 Number of days sales in accounts receivable  
 Change in cash / Change in receivables  
 Allowance for Bad Debts / Receivables  
 Current Ratio  
 Quick Ratio  
 Inventory / Current Assets  
 Income from Operations / Tangible Assets  
 Allowance for Bad Debts  
 Working Capital

## Affected Account Set # 140

Account Subset - 141  
 Understate Cash  
 Overstate Bad Debt Expense

Error sources  
 40 :Recoveries not recorded

## Financial Relationships Affected by Affected Account Set 140

Net Sales / Total Assets  
 Change in cash / Change in receivables  
 Bad Debts Expense / Net Sales  
 Bonuses / Pre-tax Profit  
 Current Ratio  
 Quick Ratio  
 Inventory / Current Assets  
 Income from Operations / Tangible Assets  
 Income from Operations / Net Sales  
 Profit to Equity  
 Bad Debt Expense  
 Working Capital

## Affected Account Set # 150

Account Subset - 151  
 Understate Warranty Expense  
 Understate Estimated Liability for Warranty

Error sources  
 43 :Failure to provide adequate product warranty liability

## Financial Relationships Affected by Affected Account Set 150

Expense Accounts / Related Accounts  
 Product Warranty Expense / Net Sales  
 Bonuses / Pre-tax Profit  
 Income from Operations / Tangible Assets  
 Income from Operations / Net Sales  
 Profit to Equity  
 Expense Accounts  
 Estimated Liability for Product Warranty Expense

## Affected Account Set # 160

Account Subset - 161  
 Understate Trade Accounts Payable  
 Understate Supplies on Hand

Error sources  
 44 :Liability incurred but not recorded  
 46 :Purchases incorrectly valued

Account Subset - 162  
 Overstate Trade Accounts Payable  
 Overstate Supplies on Hand

Error sources

45 :Purchases recorded but goods not received  
 46 :Purchases incorrectly valued  
 53 :Damaged or missing goods not reported

Account Subset - 163  
 Understate Trade Accounts Payable  
 Understate Supplies on Hand  
 Delay for 1 month, then process Affected Account Subset 162

Error sources

48 :Purchases recorded in wrong period

Account Subset - 164  
 Overstate Trade Accounts Payable  
 Overstate Supplies on Hand  
 Delay for 1 month, then process Affected Account Subset 161

Error sources

48 :Purchases recorded in wrong period

Financial Relationships Affected by Affected Account Set 160  
 Purchases / Accounts Payable  
 Number of Days Purchases in Accounts Payables  
 Current Ratio  
 Quick Ratio  
 Inventory / Current Assets  
 Debt to Equity  
 Inventory Accounts  
 Trade Accounts Payable  
 Working Capital

Affected Account Set # 170

Account Subset - 171  
 Overstate Trade Accounts Payable  
 Understate Purchases Returns & Allowances

Error sources

49 :Goods returned but no credit received  
 51 :Wrong quantity/price credited for returned goods

Account Subset - 172  
 Understate Trade Accounts Payable  
 Overstate Purchases Returns & Allowances

Error sources  
 50 :Credit received but goods not returned  
 51 :Wrong quantity/price credited for returned goods

Account Subset - 173  
 Overstate Trade Accounts Payable  
 Understate Purchases Returns & Allowances  
 Delay for 1 month, then process Affected Account Subset 172

Error sources  
 52 :Wrong period credited for return

Account Subset - 174  
 Understate Trade Accounts Payable  
 Overstate Purchases Returns & Allowances  
 Delay for 1 month, then process Affected Account Subset 171

Error sources  
 52 :Wrong period credited for return

Financial Relationships Affected by Affected Account Set 170  
 Direct Materials / Cost of Sales  
 Raw Materials Turnover  
 Purchases / Accounts Payable  
 Number of Days Purchases in Accounts Payables  
 Raw Materials / Work in Process  
 Current Ratio  
 Quick Ratio  
 Inventory / Current Assets  
 Debt to Equity  
 Direct Materials  
 Inventory Accounts  
 Trade Accounts Payable  
 Working Capital

Affected Account Set # 180

Account Subset - 181  
 Understate Liabilities

Error sources  
 54 :Payments recorded but not made  
 56 :Payment amounts recorded incorrectly  
 57 :Payment based on incorrect terms or price  
 59 :Diversion of payments

Account Subset - 182  
Overstate Liabilities

Error sources

55 :Payment made but not recorded  
56 :Payment amounts recorded incorrectly  
57 :Payment based on incorrect terms or price  
60 :Duplicate payments  
61 :Payment for cancelled orders

Account Subset - 183  
Understate Liabilities  
Delay for 1 month, then process Affected Account Subset 182

Error sources

58 :Payment recorded in wrong period

Account Subset - 184  
Overstate Liabilities  
Delay for 1 month, then process Affected Account Subset 181

Error sources

58 :Payment recorded in wrong period

Financial Relationships Affected by Affected Account Set 180  
Purchases / Accounts Payable  
Number of Days Purchases in Accounts Payables  
Prepaid Expense Accounts / Related Accounts  
Current Ratio  
Quick Ratio  
Debt to Equity  
Trade Accounts Payable  
Accrued Liabilities  
Working Capital

Affected Account Set # 190

Account Subset - 191  
Understate Cash  
Overstate Prepaid Expenses

Error sources

62 :Prepayments are incorrectly valued

Account Subset - 192  
 Overstate Cash  
 Understate Prepaid Expenses

Error sources  
 62 :Prepayments are incorrectly valued

Account Subset - 193  
 Understate Cash  
 Overstate Prepaid Expenses  
 Delay for 1 month, then process Affected Account Subset 192

Error sources  
 64 :Prepayments are recorded in wrong period

Account Subset - 194  
 Overstate Cash  
 Understate Prepaid Expenses  
 Delay for 1 month, then process Affected Account Subset 191

Error sources  
 64 :Prepayments are recorded in wrong period

Financial Relationships Affected by Affected Account Set 190  
 Net Sales / Total Assets  
 Change in cash / Change in receivables  
 Prepaid Expense Accounts / Related Accounts  
 Current Ratio  
 Quick Ratio  
 Inventory / Current Assets  
 Income from Operations / Tangible Assets'  
 Prepaid Expense Accounts  
 Working Capital

Affected Account Set # 200

Account Subset - 201  
 Understate Prepaid Expense  
 Overstate Related Expense

Error sources  
 65 :Prepaid items not listed as prepaid

Account Subset - 202  
 Overstate Prepaid Expense  
 Understate Related Expense

Error sources

66 :Items listed as prepaid that are not prepaid

Financial Relationships Affected by Affected Account Set 200

Prepaid Expense Accounts / Related Accounts  
 Retained Earnings / Net Income after Tax plus Dividends  
 Bonuses / Pre-tax Profit  
 Profit to Equity  
 Expense Accounts  
 Prepaid Expense Accounts  
 Working Capital

Affected Account Set # 210

Account Subset - 211  
 Understate Accrued Payroll Expenses  
 Understate Payroll Expenses

Error sources

67 :Failure to include items that should be accrued  
 69 :Accruals incorrectly valued  
 77 :Misappropriation of unclaimed wages

Account Subset - 212  
 Overstate Accrued Payroll Expenses  
 Overstate Payroll Expenses

Error sources

68 :Accrual of items that should not be accrued  
 69 :Accruals incorrectly valued  
 72 :Employees paid for work not performed

Account Subset - 213  
 Understate Accrued Payroll Expenses  
 Understate Payroll Expenses  
 Delay for 1 month, then process Affected Account Subset 212

Error sources

70 :Accruals recorded in wrong period  
 73 :Employee wages calculated using wrong hourly rate  
 74 :Employees not paid for hours worked or production completed  
 75 :Overtime or shift differential hours not recognized  
 78 :Mathematical errors in calculation of payroll

## Account Subset - 214

Overstate Accrued Payroll Expenses

Overstate Payroll Expenses

Delay for 1 month, then process Affected Account Subset 211

## Error sources

70 :Accruals recorded in wrong period

72 :Employees paid for work not performed

73 :Employee wages calculated using wrong hourly rate

78 :Mathematical errors in calculation of payroll

## Financial Relationships Affected by Affected Account Set 210

Direct Labor / Cost of Sales

Factory Overhead / Cost of Sales

Expense Accounts / Related Accounts

Sales Expense / Gross Sales

Current Ratio

Quick Ratio

Debt to Equity

Direct Labor

Factory Overhead

Expense Accounts

Selling Expenses

Administrative Expenses

Accrued Liabilities

Working Capital

## Affected Account Set # 220

## Account Subset - 221

Understate Direct Labor

Understate Work-In-Process

## Error sources

82 :Hourly costs of direct labor incorrectly valued

83 :Hours required to manufacture a unit recorded incorrectly

93 :Costs of material, labor and overhead incorrectly recorded

## Account Subset - 222

Overstate Direct Labor

Overstate Work-In-Process

## Error sources

82 :Hourly costs of direct labor incorrectly valued

83 :Hours required to manufacture a unit recorded incorrectly

93 :Costs of material, labor and overhead incorrectly recorded

Account Subset - 223  
 Understate Direct Labor  
 Understate Work-In-Process  
 Delay for 1 month, then process Affected Account Subset 222

Error sources  
 96 :Record material, labor and overhead in wrong period

Account Subset - 224  
 Overstate Direct Labor  
 Overstate Work-In-Process  
 Delay for 1 month, then process Affected Account Subset 221

Error sources  
 96 :Record material, labor and overhead in wrong period

Financial Relationships Affected by Affected Account Set 220  
 Direct Labor / Cost of Sales  
 Work in Process Turnover  
 Direct Labor / Work in Process  
 Factory Overhead / Work in Process  
 Bonuses / Pre-tax Profit  
 Current Ratio  
 Inventory / Current Assets  
 Income from Operations / Tangible Assets  
 Income from Operations / Net Sales  
 Profit to Equity  
 Gross Profit  
 Direct Labor  
 Inventory Accounts

Affected Account Set # 230

Account Subset - 231  
 Overstate Payroll Expense  
 Understate Payroll Expense

Error sources  
 79 :Erroneous recording/classification of compensation  
 85 :Wages/salaries improperly classified

Account Subset - 232  
 Understate Payroll Expense  
 Overstate Payroll Expense

Error sources  
 79 :Erroneous recording/classification of compensation  
 85 :Wages/salaries improperly classified

Financial Relationships Affected by Affected Account Set 230

Direct Labor / Cost of Sales  
 Factory Overhead / Cost of Sales  
 Expense Accounts / Related Accounts  
 Direct Labor / Work in Process  
 Factory Overhead / Work in Process  
 Sales Expense / Gross Sales  
 Direct Labor  
 Factory Overhead  
 Selling Expenses  
 Administrative Expenses

Affected Account Set # 240

Account Subset - 241  
 Overstate Direct Materials  
 Understate Work-In-Process

Error sources

89 :Material requisitions not recorded  
 90 :Material requisitions are incorrectly recorded  
 93 :Costs of material, labor and overhead incorrectly recorded  
 94 :Cost of material, labor and overhead incorrectly valued

Account Subset - 242  
 Understate Direct Materials  
 Overstate Work-In-Process

Error sources

90 :Material requisitions are incorrectly recorded  
 93 :Costs of material, labor and overhead incorrectly recorded  
 94 :Cost of material, labor and overhead incorrectly valued

Account Subset - 243  
 Overstate Direct Materials  
 Understate Work-In-Process  
 Delay for 1 month, then process Affected Account Subset 242

Error sources

91 :Material requisitions recorded in wrong period  
 96 :Record material, labor and overhead in wrong period

Account Subset - 244  
 Understate Direct Materials  
 Overstate Work-In-Process  
 Delay for 1 month, then process Affected Account Subset 241

Error sources

91 :Material requisitions recorded in wrong period  
 96 :Record material, labor and overhead in wrong period

## Financial Relationships Affected by Affected Account Set 240

Direct Materials / Cost of Sales  
 Direct Labor / Cost of Sales  
 Work in Process Turnover  
 Direct Labor / Work in Process  
 Raw Materials / Work in Process  
 Bonuses / Pre-tax Profit  
 Current Ratio  
 Inventory / Current Assets  
 Income from Operations / Tangible Assets  
 Income from Operations / Net Sales  
 Profit to Equity  
 Gross Profit  
 Direct Materials  
 Inventory Accounts  
 Property, Plant and Equipment  
 Working Capital

## Affected Account Set # 250

Account Subset - 251  
 Overstate Work-In-Process  
 Understate Factory Overhead

## Error sources

93 :Costs of material, labor and overhead incorrectly recorded  
 94 :Cost of material, labor and overhead incorrectly valued

Account Subset - 252  
 Understate Work-In-Process  
 Overstate Factory Overhead

## Error sources

93 :Costs of material, labor and overhead incorrectly recorded  
 94 :Cost of material, labor and overhead incorrectly valued

Account Subset - 253  
 Overstate Work-In-Process  
 Understate Factory Overhead  
 Delay for 1 month, then process Affected Account Subset 252

## Error sources

96 :Record material, labor and overhead in wrong period

Account Subset - 254  
 Understate Work-In-Process  
 Overstate Factory Overhead  
 Delay for 1 month, then process Affected Account Subset 251

## Error sources

96 :Record material, labor and overhead in wrong period

Financial Relationships Affected by Affected Account Set 250

Direct Labor / Cost of Sales  
 Factory Overhead / Cost of Sales  
 Work in Process Turnover  
 Direct Labor / Work in Process  
 Raw Materials / Work in Process  
 Factory Overhead / Work in Process  
 Bonuses / Pre-tax Profit  
 Current Ratio  
 Inventory / Current Assets  
 Income from Operations / Tangible Assets  
 Income from Operations / Net Sales  
 Profit to Equity  
 Gross Profit  
 Factory Overhead  
 Inventory Accounts  
 Working Capital

Affected Account Set # 260

Account Subset - 261  
 Overstate Work-In-Process  
 Understate Finished Goods Inventory

Error sources

97 :Incorrect quantity transferred to finished goods  
 99 :Finished goods not recorded  
 100 :Finished goods recorded at incorrect value

Account Subset - 262  
 Understate Work-In-Process  
 Overstate Finished Goods Inventory

Error sources

97 :Incorrect quantity transferred to finished goods  
 100 :Finished goods recorded at incorrect value

Account Subset - 263  
 Overstate Work-In-Process  
 Understate Finished Goods Inventory  
 Delay for 1 month, then process Affected Account Subset 262

Error sources

101 :Finished goods recorded in wrong period

Account Subset - 264  
 Understate Work-In-Process  
 Overstate Finished Goods Inventory  
 Delay for 1 month, then process Affected Account Subset 261

Error sources

101 :Finished goods recorded in wrong period

## Financial Relationships Affected by Affected Account Set 260

Direct Labor / Cost of Sales  
 Factory Overhead / Cost of Sales  
 Work in Process Turnover  
 Finished Goods Turnover  
 Number of Days Sales in Finished Goods Inventory  
 Direct Labor / Work in Process  
 Raw Materials / Work in Process  
 Factory Overhead / Work in Process  
 Current Ratio  
 Inventory / Current Assets  
 Inventory Accounts  
 Working Capital

## Affected Account Set # 270

## Account Subset - 271

Understate Gross Sales  
 Understate Accounts Receivable  
 Delay for 1 month, then process Affected Account Subset 12

## Error sources

4 :Sales recorded before legal title passes  
 10 :Wrong period credited for sale  
 16 :Duplicate shipments

## Account Subset - 272

Overstate Gross Sales  
 Overstate Accounts Receivable  
 Delay for 1 month, then process Affected Account Subset 11

## Error sources

4 :Sales recorded before legal title passes  
 10 :Wrong period credited for sale  
 16 :Duplicate shipments

## Financial Relationships Affected by Affected Account Set 270

Gross Margin Percentage  
 Net Sales / Total Assets  
 Net Sales / Physical Production Volume  
 Sales Discounts / Gross Sales  
 Sales Returns and Allowances / Gross Sales  
 Sales Commissions / Net Sales  
 Sales Taxes / Gross Sales  
 Receivables Turnover  
 Number of days sales in accounts receivable  
 Change in cash / Change in receivables  
 Allowance for Bad Debts / Receivables  
 Retained Earnings / Net Income after Tax plus Dividends  
 Bad Debts Expense / Net Sales  
 Product Warranty Expense / Net Sales  
 Sales Expense / Gross Sales  
 Bonuses / Pre-tax Profit  
 Current Ratio  
 Quick Ratio  
 Inventory / Current Assets  
 Income from Operations / Tangible Assets  
 Income from Operations / Net Sales  
 Profit to Equity  
 Net Sales  
 Gross Profit  
 Receivables  
 Working Capital

## Affected Account Set # 280

Account Subset - 281  
 Overstate Accrued Payroll Expense  
 Overstate Vacation & Holiday Expense

## Error sources

76 :Employee paid for unauthorized vacation/sick time

## Financial Relationships Affected by Affected Account Set 280

Factory Overhead / Cost of Sales  
 Expense Accounts / Related Accounts  
 Retained Earnings / Net Income after Tax plus Dividends  
 Factory Overhead / Work in Process  
 Bonuses / Pre-tax Profit  
 Current Ratio  
 Quick Ratio  
 Debt to Equity  
 Expense Accounts  
 Accrued Liabilities  
 Working Capital

## Affected Account Set # 290

Account Subset - 291  
Overstate Finished Goods Inventory

## Error sources

86 :Obsolescent items maintained in inventory  
87 :Consigned out items are double counted in inventory  
88 :Consigned in items are counted in inventory  
98 :Incorrect allocation of costs of storing goods

## Financial Relationships Affected by Affected Account Set 290

Direct Materials / Cost of Sales  
Direct Labor / Cost of Sales  
Factory Overhead / Cost of Sales  
Finished Goods Turnover  
Number of Days Sales in Finished Goods Inventory  
Current Ratio  
Inventory / Current Assets  
Income from Operations / Tangible Assets  
Inventory Accounts  
Working Capital

## Affected Account Set # 300

Account Subset - 301  
Understate Inventory Obsolescence Expense

## Error sources

86 :Obsolescent items maintained in inventory

## Financial Relationships Affected by Affected Account Set 300

Expense Accounts / Related Accounts  
Retained Earnings / Net Income after Tax plus Dividends  
Bonuses / Pre-tax Profit  
Income from Operations / Tangible Assets  
Income from Operations / Net Sales  
Profit to Equity  
Expense Accounts

## Affected Account Set # 310

Account Subset - 311  
Understate Inventory Storage Expense

## Error sources

98 :Incorrect allocation of costs of storing goods

Financial Relationships Affected by Affected Account Set 310  
 Expense Accounts / Related Accounts  
 Retained Earnings / Net Income after Tax plus Dividends  
 Bonuses / Pre-tax Profit  
 Income from Operations / Tangible Assets  
 Income from Operations / Net Sales  
 Profit to Equity  
 Expense Accounts

Affected Account Set # 320

Account Subset - 321  
 Overstate Transportation Out

Error sources

103 :Goods shipped different from goods ordered  
 105 :Goods shipped to wrong party  
 106 :Goods shipped too early or too late

Financial Relationships Affected by Affected Account Set 320  
 Direct Materials / Cost of Sales  
 Direct Labor / Cost of Sales  
 Factory Overhead / Cost of Sales  
 Expense Accounts / Related Accounts  
 Retained Earnings / Net Income after Tax plus Dividends  
 Bonuses / Pre-tax Profit  
 Income from Operations / Tangible Assets  
 Income from Operations / Net Sales  
 Profit to Equity  
 Expense Accounts

Affected Account Set # 330

Account Subset - 331  
 Understate Accumulated Depreciation  
 Understate Depreciation Expense

Error sources

107 :Improper valuation of expenses

Account Subset - 332  
 Overstate Accumulated Depreciation  
 Overstate Depreciation Expense

Error sources

107 :Improper valuation of expenses

Financial Relationships Affected by Affected Account Set 330  
 Direct Materials / Cost of Sales  
 Direct Labor / Cost of Sales  
 Factory Overhead / Cost of Sales  
 Accumulated Depreciation / Related Asset Account  
 Retained Earnings / Net Income after Tax plus Dividends  
 Factory Overhead / Work in Process  
 Bonuses / Pre-tax Profit  
 Income from Operations / Tangible Assets  
 Income from Operations / Net Sales  
 Cost of Sales  
 Factory Overhead

Affected Account Set # 340

Account Subset - 341  
 Understate Expense Accounts  
 Understate Factory Overhead

Error sources  
 107 :Improper valuation of expenses

Account Subset - 342  
 Overstate Expense Accounts  
 Overstate Factory Overhead

Error sources  
 107 :Improper valuation of expenses

Financial Relationships Affected by Affected Account Set 340  
 Gross Margin Percentage  
 Direct Materials / Cost of Sales  
 Direct Labor / Cost of Sales  
 Factory Overhead / Cost of Sales  
 Retained Earnings / Net Income after Tax plus Dividends  
 Bonuses / Pre-tax Profit  
 Income from Operations / Tangible Assets  
 Income from Operations / Net Sales  
 Profit to Equity  
 Cost of Sales  
 Factory Overhead  
 Customer Service and Installation  
 Repairs and Maintenance  
 Bad Debt Expense  
 Expense Accounts  
 Prepaid Expense Accounts  
 Administrative Expenses  
 Research and Development Expenses  
 Engineering Expenses

APPENDIX C  
STRUCTURED INTERVIEW GUIDE

Preliminary Instructions

The goal of this survey is twofold: 1) to identify the analytical review techniques that are typically used during an audit of a medium sized manufacturing firm, and 2) to identify the sources and characteristics of errors and irregularities which occur in the accounting information maintained by a medium sized manufacturing firm and reported in the financial statements. The term error refers to unintentional mistakes while irregularities refers to intentional distortions of the financial statements. A medium sized manufacturing firm is defined as having annual sales of \$50 - 200 million.

The study of the sources and characteristics of errors and irregularities is focused on the processing of transactions. Assume that the manufacturing firm has designed an adequate system of internal controls that monitor the processing of transactions. Deviations in these processing tasks would increase the risk of monetary errors in the financial statement accounts. These deviations become potential sources of errors and irregularities. If these potential sources are defined, then the rate and distribution of the ensuing monetary errors can be estimated.

Since transactions represent economic events, they can be categorized by the nature of the economic event. This procedure is termed the "transaction cycle approach", and keeps closely related types of transactions and account balances in the same segment. Four transaction cycles are used in this survey: Sales and collection cycle, acquisition and payment cycle, payroll and personnel cycle, and inventory and warehousing cycle.

The questions that I will be asking do not have easy answers. I am trying to derive a consensus opinion among experts in the manufacturing industry. My role in this interview is to maintain consistency in the responses. Therefore, if any question seems unclear, please ask for clarification.

Some individuals have problems with percentage questions. Rather than think of a percentage, express the answer in terms of the number of items that you would expect out of 1000 items.

Also, the term "in your experience" is not limited to those audits in which you were a direct participant. Your answers should be based on your specific knowledge of medium-sized manufacturing firms.

Finally, we are assuming a profitable, healthful company. It is acknowledged that your responses would be different if the company faced an uncertain future.

Are there any questions before we begin?

The first section of this survey has three objectives:

- 1) To establish your audit experience.
- 2) To determine your definition of a material amount for the manufacturing industry.

The second section will identify the analytical review techniques that you typically rely on during an audit. The third and final section will concern validating the transactions and sources of monetary errors within each business cycle, and assessing your estimates of the error rates and distributions for the identified monetary errors.

Are there any questions before we begin?

## Section I

## Audit Experience

How many years of audit experience do you have? \_\_\_\_\_

What is the approximate number of all audits in which you:

- a. were an active member of the audit team? \_\_\_\_\_
- b. reviewed the results of the audit, but did not actively participate as a member of the audit team? (i.e., consultation or review) \_\_\_\_\_

What is the approximate number of audits of medium sized manufacturing firms in which you:

- a. were an active member of the audit team? \_\_\_\_\_
- b. reviewed the results of the audit, but did not actively participate as a member of the audit team? \_\_\_\_\_

## Materiality

For errors discovered during an audit of a medium sized manufacturing firm that affect income, at what percentage of net income before taxes would you consider them to be material? \_\_\_\_\_

For errors discovered during an audit of a medium sized manufacturing firm that do not affect income, at what percentage of total assets would you consider them to be material? \_\_\_\_\_

## Section II

### Identification of Analytical Review Techniques

The goal of this section is to identify the analytical review techniques that you currently use during an audit of a medium-sized manufacturing firm. The first part will address analytical review techniques applied to the relationships between accounts, while the second part will address analysis of individual accounts.

#### Account Relationships

Would you please review the following list of account relationships for completeness. Are there any specific account relationships that you typically analyze during an audit of a medium sized manufacturing firm that are not included here? (Those account relationships not used will be identified in the next section.)

Gross Margin  
 Net Sales / Total Assets  
 Net Sales / Physical Production Volume  
 Sales Discounts / Gross Sales  
 Sales Returns & Allowances / Gross Sales  
 Sales Commissions / Net Sales  
 Sales Taxes / Gross Sales  
 Receivables Turnover  
 Number of days sales in Accounts Receivable  
 Change in Cash / Change in Accounts Receivable  
 Allowance for Uncollectible Accounts / Accounts Receivable  
 Direct Materials / Cost of Sales  
 Direct Labor / Cost of Sales  
 Factory Overhead / Cost of Sales  
 Raw Materials Turnover  
 Work-In-Process Turnover  
 Finished Goods Turnover  
 Number of days sales in Finished Goods  
 Purchases / Accounts Payable  
 Number of days purchases in Accounts Payable  
 Transportation In / Sales Volume  
 Expense Accounts / Related Account  
 Prepaid Expense Accounts / Related Account  
 Accumulated Depreciation / Related Asset Account  
 Payroll Tax Expense / Salaries and Wages  
 Retained Earnings / Net Income After Tax Plus Dividends  
 Bad Debt Expense / Net Sales

Current Ratio  
 Quick Ratio  
 Inventory / Current Assets  
 Income from Operations / Tangible Assets  
 Income from Operations / Net Sales  
 Debt / Equity  
 Profit / Equity

For each of these specific account relationships, I will be asking you to provide the following information:

1) An estimate of the percentage of all audits of medium sized manufacturing firms in which the account relationship is analyzed and the results used in forming your audit opinion. (Use the last five years as a basis.)

2) The type of analysis used: Is the account relationship analyzed using reasonableness tests, time analysis, regression models, or some other test?

3) What is the typical basis for comparison that you use to evaluate the results of the analysis? Do you compare the results of the account relationship test to industry averages, the test applied to audited data from previous years, or some other basis for comparison.

Are there any questions before we begin?

## SAMPLE OF FORM

Account Relationships	Frequency of Use
	% of audits in which you analyze and use this relationship
Gross Margin (Gross profit as a percentage of sales)	
Net Sales / Total Assets	
Net Sales / Physical Production Volume	
Sales Discounts / Gross Sales	
Sales Returns and Allowances / Gross sales	
Sales Commissions / Net Sales	
Sales Taxes / Gross Sales	
Sales Expenses / Gross Sales	
Receivables Turnover (Number of days to collect receivables)	
Number of days sales in Accounts Receivables	
Change in Cash / Change in Receivables	
Allowance for Uncollectible Accounts / Accounts Receivables	
Direct Materials / Cost of Sales	
Direct Labor / Cost of Sales	
Factory Overhead / Cost of Sales	
Direct Labor / Work in Process	
Direct Materials / Work in Process	
Factory Overhead / Work in Process	
Raw Materials Turnover	
Work In Process Turnover	
Finished Goods Turnover	
Number days sales in Finished Goods Inventory	



### Individual Accounts

Would you please review the following list of individual accounts and items for completeness. Are there any individual accounts or items which you typically analyze using analytical techniques that are not included here?

Net Sales  
 Cost of Sales  
 Gross Profit  
 Direct Materials  
 Direct Labor  
 Factory Overhead  
 Customer Service and Installation  
 Repairs and Maintenance  
 Bad Debt Expense  
 Expense Accounts  
 Prepaid Expense Accounts  
 Aggregate Selling Expenses  
 Aggregate Administrative Expenses  
 Research and Development Expenses  
 Engineering Expenses  
 Receivables  
 Allowance for Doubtful Accounts  
 Inventory Accounts  
 Marketable Securities  
 Property, Plant and Equipment  
 Intangible Assets  
 Trade Accounts Payable  
 Accrued Liabilities  
 Estimated Liability for Product Warranty Expense  
 Reserve for Obsolescence  
 Working Capital

For each of these individual accounts and items, I will be asking you to provide the following information:

- 1) An estimate of the percentage of all audits of medium sized manufacturing firms in which this account or item is analyzed and the results used in forming your audit opinion.
- 2) The type of analysis used. Is the account or item analyzed using reasonableness tests, time trend analyses, percentage of gross sales, or some other test?
- 3) The typical basis for comparison that you use to evaluate the results of the analysis. Do you compare the results of the account analysis to industry averages, audited data from previous years, budget estimates for the current audit period, or some other basis for comparison?

Are there any questions before we begin?

The final question for this section concerns the criteria that you use to identify unusual fluctuations. Could you provide three to four "rules of thumb" that you typically use with these analytical review techniques to identify unusual fluctuations? (Assuming an intermediate level of audit risk is desired.)

1.

2.

3.

4.

Section III  
ASSESSMENT OF MONETARY ERRORS

Part A

Validation of Transactions and Sources

The following is a list of transactions and associated errors and irregularities for the various business cycles. Please review this list and ensure that it is complete with regards to identifying the sources of monetary errors which could be detected by analytical review techniques and procedures.

Sources of monetary errors do not include business risks associated with authorizations, approvals, substandard quality of products, etc. Analytical review includes comparisons of current balances with those of prior years, predictions of current balances based on exogenous data, and analysis of account balance interrelationships. It also includes subjective techniques such as reasonableness tests and estimates of account balances.

Transaction Types

Is the following list of transactions representative of the operations supporting a medium sized manufacturing firm?

- Sales and Collection Cycle
  - Sales Transactions
  - Sales Return Transactions
  - Cash Receipts Transactions
  - Sales Allowances Transactions
  - Bad Debt Write-off and Recovery Transactions
  - Factoring of Assigning Transactions
- Acquisition and Payment Cycle
  - Purchases Transactions
  - Purchases Returns and Allowances Transactions
  - Receipt of Goods Transactions
  - Cash Disbursements Transactions
  - Prepayments Transactions
  - Accrual Transactions
- Payroll and Personnel Cycle
  - Payments for Work Performed Transactions
  - Allocation of Labor Costs Transactions
- Inventory and Warehousing Cycle
  - Storage Transactions
  - Processing Transactions
  - Shipment Transactions

Sources of Monetary Errors and  
Associated Transactions

SALES AND COLLECTION CYCLE

Sales Transactions.

1. Goods shipped but not invoiced.
2. Sales recorded but goods not shipped.
3. Sales invoiced but not recorded.
4. Sales recorded before legal title passes:  
    Consignments.  
    Agent Deliveries.  
    Contingent Sales.
5. Invoice recorded incorrectly in journal.
6. Wrong prices used on invoice.
7. Wrong quantity shown on shipping document and sales invoice.
8. Wrong quantity shown on invoice; shipping document correct.
9. Wrong extension of quantity and price on sales invoice.
10. Wrong period credited for sale.
11. Sales classified erroneously as to type.
12. Unearned interest included as revenue.
13. Incorrect recording of sales tax liability.
14. Sales Commission erroneously recorded.
15. Quoted price not used on invoice.
16. Duplicate shipments.
17. Billing terms incorrect.
18. Billing of wrong customer.
19. Other (Specify)

Sales Return Transactions.

1. Goods returned; no credit given to customer.
2. Goods not returned; credit given to customer.
3. Returns classified erroneously as to type.
4. Credit given for goods never recorded as a sale.
5. Goods returned, but not re-entered into company inventory system.
6. Wrong quantity/price credited for returned goods.
7. Error in extension on credit memorandum.
8. Wrong period credited for return.
9. Wrong items credited for return.
10. Other (Specify)

Sales Allowances Transactions.

1. Sales allowance granted but not recorded.
2. Wrong period credited for allowances.
3. Sales allowance incorrectly valued.

Cash Receipts Transactions. (Cash sales, collection of accounts receivable,  
return on investments, and cash transfers.)

1. Cash not deposited or recorded.
2. Cash recorded but not deposited.
3. Cash deposited but not recorded.
4. Cash amount recorded incorrectly.
5. Cash credited to wrong sub-account.
6. Cash recorded in wrong period.
7. Improper interest collected on interest-bearing accounts.
8. Other (Specify)

Bad Debt Write-off Transactions.

1. Collectible accounts written-off.
2. Uncollectible accounts not written-off.
3. Recoveries not recorded.
4. Other (Specify)

Factoring or Assigning Transactions.

1. Sale or assignment of accounts receivable not recorded.
2. Cash proceeds from sale or assignment not deposited.
3. Other (Specify)

Other Transactions.

Sources of Monetary Errors and  
Associated Transactions

ACQUISITION AND PAYMENT CYCLE

Purchases Transactions.

1. Purchases recorded but goods not received or services not performed.
2. Liability incurred but not recorded.
3. Purchases incorrectly valued.
4. Purchases incorrectly classified.
5. Purchases recorded in wrong period.
6. Other (Specify)

Purchases Returns and Allowances Transactions.

1. Goods returned but no credit received.
2. Credit received but goods not returned.
3. Wrong quantity/price credited for returned goods.
4. Wrong period credited for return.
5. Other (Specify)

Receipt of Goods Transactions.

1. Damaged or missing goods not reported.

Cash Disbursements Transactions. (Including accounts payable, other accrued liabilities, and cash transfers.)

1. Payments recorded but not made.
2. Payments made but not recorded.
3. Payment amounts recorded incorrectly.
4. Payments based on incorrect terms or price.
5. Payments recorded in wrong period.
6. Diversion of payments.
7. Duplicate payments.
8. Payments for cancelled orders.
9. Other (Specify)

Prepayments Transactions.

1. Prepayments are incorrectly valued.
2. Related expenses not properly classified.
3. Prepayments recorded in wrong period.
4. Prepaid items not listed as prepaid.
5. Items listed as prepaid that are not prepaid.
6. Other (Specify)

Accrual Transactions.

1. Failure to include items that should be accrued.
2. Accrual of items that should not be accrued.
3. Accruals incorrectly valued.
4. Accruals recorded in wrong period.
5. Related expenses not properly classified.
6. Other (Specify)

Other Transactions.

Sources of Monetary Errors and  
Associated Transactions

PAYROLL AND PERSONNEL CYCLE

Payments for Work Performed Transactions.

1. Employees paid for work not performed.
2. Employee wages calculated using wrong hourly rate.
3. Employee not paid for hours worked or production completed.
4. Overtime or shift differential hours not recognized.
5. Employee paid for unauthorized vacation/sick time.
6. Misappropriation of unclaimed wages.
7. Mathematical errors in calculation of payroll.
8. Erroneous recording/classification of compensation.
9. Incorrect handling of end-of-period payroll accruals.
10. Expense reimbursement inaccurately calculated.
11. Other (Specify)

Allocation of Labor Costs.

1. Hourly costs of direct labor incorrectly valued.
2. Hours required to manufacture a unit of output recorded incorrectly.
3. Labor performed but not correctly allocated.
4. Wages/salaries improperly classified.
5. Other (Specify)

Other Transactions.

Sources of Monetary Errors and  
Associated Transactions

INVENTORY AND WAREHOUSING CYCLE

Storage Transactions.

1. Obsolescent and defective items are maintained in inventory.
2. Consigned out items are double counted in inventory records.
3. Consigned in items are counted in inventory.
4. Other (Specify)

Processing Transactions.

(Assume that interim physical inventories are conducted)

Raw Materials to Work-In-Process.

1. Material requisitions not recorded.
2. Material requisitions are incorrectly recorded.
3. Material requisitions recorded in wrong period.
4. Material requisitions incorrectly classified.
5. Other (Specify)

Work-In-Process to Finished Goods.

1. Costs of material, labor, and overhead incorrectly recorded.
2. Costs of material, labor, and overhead incorrectly valued.
3. Costs of material, labor, and overhead incorrectly classified.
4. Costs of material, labor, and overhead recorded in wrong period.
5. Incorrect quantity transferred to finished goods.
6. Finished goods not recorded.
7. Finished goods recorded at incorrect value.
8. Finished goods recorded in wrong period.
9. Other (Specify)

Shipment Transactions.

1. Quantity shipped does not agree with quantity ordered.
2. Goods shipped different from goods ordered.
3. Goods shipped to fictitious customers.
4. Goods shipped to wrong party.
5. Goods shipped too early or too late.
6. Other (Specify)

Other Transactions.

## Part B

## Error Analysis

In this final section of the survey, we will determine your estimates of the error rates and distributions, based on your audit experience. Please try to limit your analysis of the questions to medium sized firms within the manufacturing industry.

For each of the sources of monetary errors defined in the last section, you will be asked to estimate:

1. The percentage of all audits in which you would expect the type of error to occur. This estimate includes errors which occur but are not detected during the audit.
2. How often material errors of that type occur.
3. How the monetary errors are spread across the monthly account balances.
4. The largest error of that type which you would expect to find.

Are there any questions before we begin?

## SAMPLE OF FORM

## Sales Transactions

Questions	Sources of Errors and Irregularities		
	Goods shipped, but not invoiced.	Sales recorded, but goods not shipped.	Sales invoiced, but sales recorded before legal title passes.
1. In your experience, on what percentage of all audits would you expect this type of error to occur (including errors which occur but are not discovered)?			
2. When such errors do occur during an audit, on what percentage of those audits would you expect the amount of such errors to be: (a) Material by themselves? (b) Immaterial when aggregated with other types of errors? (c) Not material on any basis?			
3. When such errors do occur during an audit, on what percentage of audits would you expect the distribution of the monetary error over time to be: (a) All in a single month? (b) All in a single quarter? (c) Evenly dispersed throughout the year? (d) With no specific pattern? (e) At the end of interim periods?			
4. In your experience, what percentage of net income before tax best represents: (a) The largest error of this type that you would expect to find? (b) The largest irregularity of this type that you would expect to find?			

APPENDIX D  
FOLLOW-UP QUESTIONNAIRE

General Instructions

This is a follow-up questionnaire to the interviews conducted as part of our study on analytical review. The purpose of this questionnaire is to corroborate the results of the initial interviews. A lack of consensus exists for some of these results, and it is necessary to explore these areas further.

The interviews were oriented toward the specific auditing experience of the participants. This questionnaire is more general in nature, and is oriented toward your general knowledge of auditing rather than your specific experience.

The format of the questionnaire also has changed. We have tried to present the results in a concise manner which still conveys the underlying relationships. We will be asking for your opinion as to whether these relationships seem reasonable. We will also be asking you to help us explain certain results.

The questionnaire should take about 30 to 45 minutes to complete. While it may seem tedious, it is necessary to validate the information which you have already provided. This process will strengthen the results of the study.

Thank you again for your help.

Section I  
Analytical Review

There are three parts to this section: (A) analysis of account relationships, (B) analysis of individual account balances, and (C) evaluation of the rules of thumb used to generate expectations of account relationships or balances.

Part A

Account Relationships

1. Five columns are used to categorize the percentage of audits in which the various account relationships are analyzed and the results used in forming the audit opinion.

Column A: The technique is used on less than 20% of the audits.

Column B: The technique is used on 20% - 35% of the audits.

Column C: The technique is used on 35% - 50% of the audits.

Column D: The technique is used on 50% - 65% of the audits.

Column E: The technique is used on more than 65% of the audits.

The intervals for the categories were derived by partitioning the averaged responses into five groups of equal size. The dividing lines were then adjusted to ensure maximum separation between the groups. Hence, the dividing lines represent gaps between five approximately equal-sized groups of responses. Each account relationship appears in only one group.

Since each group contains approximately the same number of responses, they can be thought of as categories of usage. The group in column A is seldom used, while the group in column E is frequently used.

The various account relationships are depicted within the groups using blocks similar to the one below.

Gross Margin Percentage
agree ___ move to ___

If you agree that it is reasonable that gross margin percentage is analyzed with some analytical technique on more than 65% of the audits, then check "agree". If you believe that the relationship would be more appropriate in another group, then enter the appropriate column in "move to". (e.g., move to D)

The percentage of audits in which this relationship is analyzed and the results used in forming the audit opinion is:

Sales Taxes / Gross Sales	agree move to	Sales Discounts / Gross Sales	agree move to	Sales Commissions / Net Sales	agree move to	Gross Margin Percentage	agree move to
Change in cash / Change in receivables	agree move to	Prepaid Expense Accounts / Related Accounts	agree move to	Number of days sales in accounts receivable	agree move to	Receivables Turnover	agree move to
Purchases / Accounts Payable	agree move to	Accumulated Depreciation / Related Asset Account	agree move to	Direct Labor / Cost of Sales	agree move to	Allowance for Bad Debts / Receivables	agree move to
Number of days Purchases in Accounts Payables	agree move to	Payroll Tax Expenses / Wages and Salaries Expense	agree move to	Factory Overhead / Cost of Sales	agree move to	Direct Materials / Cost of Sales	agree move to
Transportation in / Physical Purchases Volume	agree move to	Direct Labor / Work in Process	agree move to	Raw Materials Turnover	agree move to	Finished Goods Turnover	agree move to
Inventory / Current Assets	agree move to	Raw Materials / Work in Process	agree move to	Work in Process Turnover	agree move to	Current Ratio	agree move to
Income from Operations / Tangible Assets	agree move to	Factory Overhead / Work in Process	agree move to	Number of days Sales in Finished Goods Inventory	agree move to	Income from Operations / Net Sales	agree move to
		Bonuses / Pre-tax Profit	agree move to	Expense Accounts / Related Accounts	agree move to		
		Profit to Equity	agree move to	Debt to Equity	agree move to		
		agree move to	agree move to	agree move to	agree move to		
Less than 20% (Seldom)	B 20% - 35%	C 35% - 50% (Occasionally)	D 50% - 65%	E Greater than 65% (Frequently)			

2. The following relationships are categorized according to the number of participants who compared the relationship to industry averages. (There were 13 participants in the survey)

Four to six participants:

Gross Margin Percentage  
Current Ratio  
Income for Operations / Net Sales

One to three participants:

Net Sales / Total Assets  
Net Sales / Physical Production Volume  
Sales Discounts / Gross Sales  
Sales Returns and Allowances / Gross Sales  
Sales Commissions / Net Sales  
Receivables Turnover  
Change in cash / Change in receivables  
Allowance for Bad Debts / Receivables  
Direct Materials / Cost of Sales  
Direct Labor / Cost of Sales  
Factory Overhead / Cost of Sales  
Raw Materials Turnover  
Retained Earnings / Net Income after Tax plus Dividends  
Bad Debts Expense / Net Sales  
Factory Overhead / Work in Process  
Product Warranty Expense / Net Sales  
Quick Ratio  
Inventory / Current Assets  
Income from Operations / Tangible Assets  
Debt to Equity

No participants:

Sales Taxes / Gross Sales  
Number of days sales in accounts receivable  
Work in Process Turnover  
Finished Goods Turnover  
Number of Days Sales in Finished Goods Inventory  
Purchases / Accounts Payable  
Number of Days Purchases in Accounts Payables  
Transportation In / Physical Purchases Volume  
Expense Accounts / Related Accounts  
Prepaid Expense Accounts / Related Accounts  
Accumulated Depreciation / Related Asset Account  
Payroll Tax Expenses / Wages and Salaries Expense  
Direct Labor / Work in Process  
Raw Materials / Work in Process  
Sales Expense / Gross Sales  
Bonuses / Pre-tax Profit  
Profit to Equity

Why didn't more auditors compare these relationships to industry averages?  
(Note: Do not address the specific relationships. We are trying to explain the apparent low use of industry averages.)

## Part B

## Account Balances

1. Five columns are used to categorize the percentage of audits in which the various account balances are analyzed and the results used in forming the audit opinion.

Column A: The technique is used on less than 35% of the audits.

Column B: The technique is used on 35% - 55% of the audits.

Column C: The technique is used on 55% - 75% of the audits.

Column D: The technique is used on 75% - 90% of the audits.

Column E: The technique is used on more than 90% of the audits.

Again, the groups represent approximate equal size while maintaining maximum separation between the groups. The averaged responses concerning analytical analysis of the account balances determined the categorization. The format of the questionnaire is similar to Part A1.



2. The following accounts are categorized according to the number of participants who analyzed the account as a percentage of gross sales.

Four to six participants:

Net Sales  
Direct Materials  
Direct Labor  
Factory Overhead  
Bad Debt Expense  
Expense Accounts  
Allowance for Bad Debts  
Inventory Accounts

One to three participants:

Customer Service and Installation  
Repairs and Maintenance  
Prepaid Expense Accounts  
Selling Expenses  
Administrative Expenses  
Research and Development Expenses  
Engineering Expenses

Why didn't more auditors analyze these accounts as a percentage of gross sales?  
(Note: Do not address the specific relationships. We are trying to explain the apparent low use of percentage of gross sales analysis.)

3. The following accounts are categorized according to the number of participants who compared the results of the analytical analysis of the account to industry averages.

Four to six participants:

Net Sales  
Cost of Sales

One to three participants:

Direct Materials  
Direct Labor  
Factory Overhead  
Bad Debt Expense  
Expense Accounts  
Receivables  
Allowance for Bad Debts  
Inventory Accounts  
Property, Plant and Equipment  
Trade Accounts Payable  
Estimated Liability for Product Warranty Expense  
Working Capital

No participants:

Customer Service and Installation  
Repairs and Maintenance  
Prepaid Expense Accounts  
Selling Expenses  
Administrative Expenses  
Research and Development Expenses  
Engineering Expenses  
Marketable Securities  
Intangible Assets  
Accrued Liabilities  
Reserve for Obsolescence

Why didn't more auditors compare the results of the analytical analysis of these accounts to industry averages?  
(Note: Do not address the specific relationships. We are trying to explain the apparent low use of industry averages.)

4. The following accounts are categorized according to the number of participants who compared the results of the analytical analysis of the account to budget estimates.

Four to six participants:

- Direct Materials
- Direct Labor
- Customer Service and Installation
- Bad Debt Expense
- Inventory Accounts
- Estimated Liability for Product Warranty Expense

One to three participants:

- Prepaid Expense Accounts
- Selling Expenses
- Administrative Expenses
- Research and Development Expenses
- Engineering Expenses
- Receivables
- Allowance for Bad Debts
- Marketable Securities
- Intangible Assets
- Trade Accounts Payable
- Accrued Liabilities
- Reserve for Obsolescence
- Working Capital

Why didn't more auditors compare the results of the analytical analysis of these accounts to budget estimates?  
(Note: Do not address the specific relationships. We are trying to explain the apparent low use of budget estimates.)

## Part C

## Rules of Thumb

A general consensus among the participants was that an auditor should form an expectation of the variation in an account, and investigate any differences from this expected variation. We are interested in defining some criteria which suggests when an auditor should investigate a variation.

Listed below are some rules of thumb which describe some decision rules which can be applied to analytical tests. The two sub-sections divide Income Statement Accounts from Balance Sheet Accounts. These rules of thumb were provided by the participants during the interview. Please choose at least four of the methods within each sub-section in the order of your preference concerning their use as criteria for investigating an expected variation.

Income Statement Accounts.

- a. Investigate if the variation differs from the rate of inflation.
- b. Investigate if the balance of an income statement account exceeds 3% of sales and changes 10% from the previous year.
- c. Investigate if the balance changes 5% from the budgeted amount and the monetary value of the variation exceeds 5% of the functional category.
- d. Investigate if the balance varies 5% from the previous year and the monetary value of the variation exceeds 5% of the functional category.
- e. Investigate if the balance of an income statement account exceeds 5% of pre-tax income and changes 10% from the previous year.
- f. Investigate if the components in Cost of Sales vary more than 10% from the variation in Net Sales.
- g. Investigate if the change in the account balance is more than 10% of the change in the previous years account balance.
- h. Investigate if the change in the account varies more than 10% from the budget.
- i. Investigate if an income statement account, expressed as a percentage of gross sales, varies 2% from the previous year.
- j. Investigate if an income statement account, expressed as a percentage of gross sales, varies 10% from the previous year.
- k. Other (Please specify)

Balance Sheet Accounts

- a. Investigate if the variation differs from the rate of inflation.
- b. Investigate if the balance of a balance sheet account exceeds 5% of total assets and changes 10% from the previous year.
- c. Investigate if the balance changes 5% from the budgeted amount and the monetary value of the variation exceeds 5% of the functional category.
- d. Investigate if the balance varies 5% from the previous year and the monetary value of the variation exceeds 5% of the functional category.
- e. Investigate if the balance of a balance sheet account exceeds 7% of total assets and changes 10% from the previous year.
- f. Investigate if the change in the account balance is more than 10% of the change in the previous years account balance.
- g. Investigate if the change in the account varies more than 10% from the budget.

## Section II

## Sources of Errors in Financial Data

There are three parts in this section: (A) analysis of the distribution of the monetary error over time, (B) analysis of the frequency of errors and their variation, and (C) analysis of the largest error expected.

## Part A

## Distribution of the Monetary Errors

For each source of error, participants were asked:

When such errors do occur during an audit, on what percentage of audits would you expect the distribution of the monetary error over time to be: (a) all in a single month, (b) all in a single quarter, (c) evenly dispersed throughout the year, (d) with no specific pattern, and (e) at the end of the period.

The sources of errors were categorized by the type of error they represent (cutoff, classification, valuation, recording, or other). The responses to each possible distribution were then averaged within the error categories. The results are presented in the table below. For example, assume that cutoff errors are found in 100 audits of medium-sized manufacturing firms. In 7 audits, all the errors would occur in a single month; in 25 audits, the errors would be evenly dispersed throughout the year; in 21 audits there would be no specific pattern to the errors; and in 47 audits the errors would occur at the end of the reporting periods. Note that each row totals to 100%.

Averaged Distribution of Errors

Type of Error	Single Month	Single Quarter	Evenly Dispersed	No Specific Pattern	End of Period
Cutoff	7	0	25	21	47
Classification	11	1	38	37	13
Valuation	16	1	31	45	7
Recording	12	2	32	38	16

Table 1

In your opinion, do these results seem reasonable? If they do not seem reasonable, please change the table so it reflects your opinion of what is a reasonable distribution of the monetary errors over time.

## Part B

## 1. Frequency of Errors

For each of 106 potential sources of errors in financial data, participants were asked the following questions:

(1) In your experience, on what percentage of all audits would you expect this type of error to occur (including errors which occur but are not discovered), and (2) when such errors do occur during an audit, on what percentage of those audits would you expect the amount of such errors to be: (a) material by themselves, and (b) material when aggregated with other types of errors?

The participants' responses were consistent for those error sources which seldom occur. Consistent responses also were achieved on some of the error sources which occur occasionally and frequently. But in general, a lack of consensus in the participants' responses existed for most of the error sources which had a high frequency of occurrence. We need to refine the estimated frequencies for these error sources.

Toward this end, we have categorized the averaged responses for each error source according to the percentage of audits in which a monetary error is expected to result. The averaged responses for all 106 error sources were divided into seven groups of equal size. The intervals of the groups were then adjusted to maximize separation between the groups. Again, the groups can be thought of as usage categories. These are depicted on the following scale:

Usage:	Seldom Used		Occasionally Used			Frequently Used	
	A	B	C	D	E	F	G
Intervals for each question							
1	0 - 8	12	15	20	28	36	100
2a	0 - 1	1 3/4	2 1/2	4	6	12	100
2b	0 - 5	8	11	14	17	20	100

For each of the three questions (1, 2a, and 2b), the responses are diagrammed in a separate sub-section (1, 2, and 3). The first sub-section concerns the frequency of monetary errors in audits, while the second and third sub-sections concern the frequency of material monetary errors in audits. The results are presented by major transaction cycle to make the analysis more manageable.

Please review the following pages and re-assess the frequency with which the error sources are expected to occur. If you agree with the classification as determined by the averaged responses, then check "agree". If you believe that the percentage of audits in which the error source is expected to occur is different from the classification, then enter the more appropriate column (A thru G) in the "move to" space. Note that columns A and B are not presented since none of these error sources fell within those percentages.

1. The percentage of audits in which a monetary error would result from this source of error is:

Sales and Collection Cycle

Cash deposited but not recorded agree move to	Wrong period credited for allowance agree move to	Wrong quantity price credited for returned goods agree move to
Sales invoiced but not recorded agree move to	Goods returned but not recntered into inventory system agree move to	Goods shipped but not invoiced agree move to
Less than 15% C	Wrong period credited for return agree move to	Wrong prices used on invoice agree move to
15% - 20% E (Occasionally)	Cash credited to wrong sub-account agree move to	Wrong period credited for sale agree move to
20% - 25% E	Collectible accounts written-off agree move to	Wrong period credited for sale agree move to
25% - 36% F	Wrong quantity shown on shipping document and sales invoice agree move to	Wrong period credited for sale agree move to
Greater than 36% G (Frequently)	Billing terms incorrect agree move to	Wrong period credited for sale agree move to

2. Given that a monetary error has occurred, the percentage of audits in which this monetary error is material by itself is:

Sales and Collection Cycle

Less than 2 1/2%	C	Sales allowance incorrectly valued	agree move to	2 1/2% - 4% (Occasionally)	D	
		Billing of wrong customer	agree move to	4% - 6%	E	
		Incorrect recording of sales tax liability	agree move to	6% - 12%	F	
		Cash recorded in wrong period	agree move to			
		Goods shipped but not invoiced	agree move to			
		Sales recorded but goods not shipped	agree move to			
		Sale or assignment of receivables not recorded	agree move to			
		Cash proceeds from sale or assignment not deposited	agree move to			
		Uncollectible accounts not written-off	agree move to			Greater than 12% (Frequently)
		Sales recorded before legal title passes	agree move to			
		Failure to provide adequate product warranty liability	agree move to			

3. Continued

Given that a monetary error has occurred, the percentage of audits in which this monetary error is material when aggregated with other related errors is:

Acquisition and Payments Cycle

Less than 11% <sup>C</sup>	Purchases incorrectly classified agree ___ move to	11% - 14% (Occasionally)	Payments recorded but not made agree ___ move to	14% - 17% <sup>E</sup>	Purchases recorded but goods not received agree ___ move to	17% - 20% <sup>F</sup>	Purchases recorded in wrong period agree ___ move to	Liability incurred but not recorded agree ___ move to	Diverison of payments agree ___ move to	Greater than 20% <sup>G</sup> (Frequently)

Inventory and Warehousing Cycle

Less than 11% <sup>C</sup>	11% - 14% (Occasionally)	Finished goods recorded in wrong period agree ___ move to	14% - 17% <sup>E</sup>	Cost of material, labor and overhead incorrectly valued agree ___ move to	17% - 20% <sup>F</sup>	Goods shipped to fictitious customer agree ___ move to	Obsolescent items maintained in inventory agree ___ move to	Greater than 20% <sup>G</sup> (Frequently)

## 2. Variation in Responses

For many of the sources of errors, there was a wide variation in the responses to the three questions concerning the frequency of errors. We would like your opinion as to why these variations exist.

For each of the three questions concerning the frequency of errors, we have listed three sources of errors. Immediately below each error source are the actual responses given by the thirteen participants. The response you gave is circled. After each listed error source, please give us your opinion as to why the responses are so varied.

## Question 1

In your experience, on what percentage of all audits would you expect this type of error to occur?

1. Invoice recorded incorrectly in journal  
 Sales transaction      Recording error.  
 Responses :    1    5    5    5    5    5    5    10    10    95    100    100    100

2. Liability incurred but not recorded  
 Purchases transaction      Recording error.  
 Responses :    10    25    50    50    50    70    100    100    100    100    100    100    100

3. Accruals recorded in wrong period  
 Accruals transaction      Cutoff error.  
 Responses :    5    5    20    20    20    25    40    50    50    60    75    100    100

## Question 2

When such errors do occur during an audit, on what percentage of those audits would you expect the amount of such errors to be material by themselves?

1. Sales recorded but goods not shipped  
     Sales transaction      Recording error.

Responses :   0   0   0   1   5   5   10   10   10   15   50   50   75

2. Failure to provide adequate product warranty liability  
     Other transaction      Other error.

Responses :   0   0   5   5   5   10   20   25   30   50   50   60   60

3. Purchases recorded in wrong period  
     Purchases transaction      Cutoff error.

Responses :   0   0   1   5   5   10   10   20   25   25   30   50   50

## Question 3

When such errors do occur during an audit, on what percentage of those audits would you expect the amount of such errors to be material when aggregated with other related types of errors?

1. Failure to provide adequate product warranty liability  
     Other transaction      Other error.

Responses :   0   0   0   5   10   10   15   20   30   40   50   50   50

2. Goods returned but not reentered into inventory system  
     Sales Return transaction      Other error.

Responses :   0   0   0   0   1   4   5   10   50   50   70   80   100

3. Wrong period credited for sale  
     Sales transaction      Cutoff error.

Responses :   0   5   10   18   20   20   30   30   40   50   60   70   90

## Part C

## Largest Expected Error

For each of the 106 error sources, the participants were asked:

In your opinion, what percentage of net income before tax best represents: (a) the largest error of this type that you would expect to find, and (b) the largest irregularity of this type that you would expect to find.

In other words, given that an error or irregularity of this type has occurred, how large could it be? (an irregularity is defined as an intentional error.)

The responses to these questions from each participant were standardized to represent multiples of a material amount. This was accomplished by dividing each participants' responses by the percentage of net income before tax that the participant considered material. The sources were then categorized according to the middle response (median).

These categories do not denote equal-sized groups. One-half of a material amount was chosen for the intervals to maintain consistent magnitudes between groups. The categories represent intervals of:

- A: Greater than 2 times a material amount (2 M)
- B: 1.5 M to 1.9 M
- C: 1.0 M to 1.4 M
- D: .5 M to .9 M
- E: Less than one-half a material amount

On the following pages, the sources of errors are listed within the respective materiality category. Only those error sources where the largest expected error/irregularity exceeded one-half of a material amount are included. Please indicate whether you agree that the classification of each error source is reasonable, or whether you believe that the source should be moved to another category.

## 1. Largest Error

- A. Given that an error of the following type has occurred, its largest expected size is typically greater than 2.5 times a material amount.

Agree      Move to

Sales transactions

- |     |     |   |
|-----|-----|---|
| ___ | ___ | : Goods shipped but not invoiced                              |
| ___ | ___ | : Sales invoiced but not recorded                             |
| ___ | ___ | : Invoice recorded incorrectly in journal                     |
| ___ | ___ | : Wrong prices used on invoice                                |
| ___ | ___ | : Wrong quantity shown on shipping document and sales invoice |
| ___ | ___ | : Wrong quantity shown on invoice; shipping document correct  |
| ___ | ___ | : Wrong extension of quantity and price on sales invoice      |
| ___ | ___ | : Sales classified erroneously as to type                     |
| ___ | ___ | : Incorrect recording of sales tax liability                  |
| ___ | ___ | : Sales commission erroneously recorded                       |
| ___ | ___ | : Quoted price not used on invoice                            |
| ___ | ___ | : Billing terms incorrect                                     |
| ___ | ___ | : Billing of wrong customer                                   |

Sales Return transaction

- |     |     |  |
|-----|-----|--|
| ___ | ___ | : Goods returned; no credit given to customer            |
| ___ | ___ | : Credit given for goods never recorded as a sale        |
| ___ | ___ | : Goods returned but not reentered into inventory system |
| ___ | ___ | : Wrong quantity/price credited for returned goods       |
| ___ | ___ | : Wrong period credited for return                       |

Sales Allowances transactions

- |     |     |                                       |
|-----|-----|---------------------------------------|
| ___ | ___ | : Allowance granted but not recorded  |
| ___ | ___ | : Wrong period credited for allowance |

Cash Receipts transactions

- |     |     |                                   |
|-----|-----|-----------------------------------|
| ___ | ___ | : Cash recorded but not deposited |
| ___ | ___ | : Cash deposited but not recorded |
| ___ | ___ | : Cash recorded in wrong period   |

## APPENDIX E

### THE ASSOCIATIONS BETWEEN ERROR SOURCES AND FINANCIAL RELATIONSHIPS

This appendix presents the many-to-many associations between the potential sources of monetary error and the financial relationships typically analyzed during an audit of a medium-sized manufacturing firm. The error sources are listed across the top as columns and the financial relationships are listed on the side as rows. An "X" in the intersection of a row and column indicates that the monetary error which results from a potential source of error affects the financial accounts included in the financial relationship.

For each potential error source, the assessed likelihood that a material monetary error will result is presented. Material monetary errors may result from a single source of error or from related sources of error. The values presented represent the percentage of audits in which material monetary errors are expected to result from the potential sources.

































## APPENDIX F

### TEST OF THE SIMULATION MODEL

#### Introduction

The simulation model depicted in Figure 1 (presented in Chapter 3) was tested to ensure that the major processes functioned correctly. A description of the evaluation procedures for each process is provided.

#### Select Monetary Error Source

Selection of the monetary error sources was accomplished by arranging the monetary error source input file in the sequential order of descending error rates. Sequential access to the file insured selection of the monetary error sources in the appropriate order.

Two monetary error sources were chosen for the test sequence: (a) goods shipped but not invoiced, and (b) wrong period credited for sale. These error sources each affect four financial account balances. The first error source seeds cumulative errors into the financial data while the second error source seeds a cutoff error.

#### Affected Account Sets

The file of affected account sets includes a secondary key which contains a code for the monetary error sources. A many-to-

many relationship exists between the monetary error sources and the affected account sets. That is, each monetary error source may be associated with one or more affected account sets, and each affected account set may be associated with one or more monetary error sources. The affected account set determines the financial accounts which are seeded with errors, which subsequently determines the financial relationships which are analyzed.

Multiple use of the same affected account set will produce redundant results. Thus, a use flag is included in the affected account set file which is set to "on" once the affected account set is employed in the simulation process. Subsequent monetary error sources which are associated with the used affected account set are bypassed since they have, in essence, already been analyzed.

The affected account sets included in the test sequence are:

a. Understate gross sales, accounts receivable, and cost of goods sold, and overstate finished goods inventory (a combination of affected account subsets 21 and 31 from Appendix B). The affected account set is associated with the goods shipped but not invoiced error source. Monetary errors which result from this error source should have a cumulative effect, being present in each month following the seeded month.

b. The second affected account set is similar to the first, except that it represents a cutoff error which reverses the seeding process in the month following the affected month. Thus, gross sales will be understated in month  $m$ , and overstated by the same amount in month  $m+1$ . Since the monetary error does not have a cumulative effect, all months following the effected month will not be affected by the monetary error.

The affected account sets also determine the financial relationships which are impacted by the financial accounts seeded

with monetary errors. Within this study, three basic forms of financial relationships are analyzed: (a) ratios, (b) income statement accounts, and (c) balance sheet accounts. One financial relationship of each form was selected for the test sequence. Specifically, (a) gross margin percentage, (b) gross profit, and (c) accounts receivable. Additionally, net sales was included to validate the use of a linear model for time series predictions.

#### Seeding of Monetary Errors

A special financial data set was created for the test sequence. The major financial accounts in the test data set included gross sales, net sales, cost of sales, administrative expenses, accounts receivable, finished goods inventory, and current liabilities. The balances of other financial accounts in the balance sheet were established to maintain a balanced condition, while the balances of other income statement accounts were derived from the major accounts listed above.

The balance in the major financial accounts were established using a random walk from a baseline. For income statement accounts, the baseline represented a yearly increase of ten percent. The baseline for balance sheet accounts was limited to a yearly increase of two and one-half percent. The baselines were intended to simulate an environment of steady, but slow growth with increasing prices. Thus, revenues and expenses increased at a faster rate than the stock accounts.

Table 36 presents the ending cumulative balances in the current audit period for each financial account included in the test data set. Table 37 presents the four year sequence of cumulative monthly balances for the financial accounts actually evaluated during the test sequence. Namely, net sales, gross profit, and

TABLE 36

CUMULATIVE END-OF-YEAR BALANCES  
OF TEST DATA FINANCIAL ACCOUNTS

Financial Account	Balance
Gross Sales . . . . .	1,302
Net Sales . . . . .	1,290
Cost of Sales . . . . .	662
Gross Profit . . . . .	628
Administrative Expenses . . . . .	300
Operating Income . . . . .	328
Taxable Income . . . . .	328
Net Income . . . . .	328
Accounts Receivable . . . . .	213
Finished Goods Inventory . . . . .	110
Current Assets . . . . .	323
Property, Plant & Equipment . . . . .	524
Total Assets . . . . .	847
Current Liabilities . . . . .	381
Long Term Liabilities . . . . .	127
Total Liabilities . . . . .	508
Total Equity . . . . .	339
Total Liabilities & Equity . . . . .	847

TABLE 37  
 CUMULATIVE FINANCIAL DATA USED IN TEST SEQUENCE

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Net Sales												
19x1	64	138	213	284	361	437	519	603	688	772	855	942
19x2	83	175	270	360	451	540	631	726	817	913	1,009	1,104
19x3	92	188	284	380	476	577	676	780	888	992	1,095	1,200
19x4	102	210	313	422	524	632	736	844	950	1,063	1,176	1,290
Gross Profit												
19x1	33	71	109	142	182	219	260	303	344	384	425	469
19x2	38	85	132	179	226	274	319	368	413	462	513	561
19x3	45	94	139	186	233	283	334	385	438	490	540	591
19x4	50	103	155	205	256	308	359	411	462	515	571	628
Accounts Receivable												
19x1	203	200	210	203	205	208	206	210	202	205	206	204
19x2	202	208	205	209	205	210	206	205	209	208	211	213
19x3	212	207	211	208	214	210	213	211	212	216	214	216
19x4	210	214	217	214	215	210	215	209	210	214	212	213

accounts receivable. The current audit period is designated "19X4" in Table 37.

Testing that the simulation model correctly seeds the monetary errors into the financial accounts involves three aspects: (a) ensuring that all accounts which are directly or indirectly affected are seeded, (b) ensuring that cutoff errors only alter the financial balances of the affected month, and (c) validating that the amount seeded corresponds with the specified monthly distributions.

Table 38 presents the results for seeding cutoff errors of a material amount in January. The accounts directly affected are gross sales, accounts receivable, finished goods inventory, and cost of sales. An understatement in gross sales will also understate net sales, gross profit, operating income, taxable income, net income, owners equity (total equity in the test data set), and total liabilities and equity. An understatement in cost of sales will overstate gross profit, operating income, taxable income, net income, total equity, and total liabilities and equity. As shown in Table 38, the simulation model does seed the monetary error into the proper financial accounts.

Table 38 also depicts the reversing process for cutoff errors. Note that the end result is that only the cumulative balances in January are altered. Actually, the January balance is overstated (understated) and the February balance is understated (overstated) by the error amount. Table 38 shows that the simulation model correctly handles the seeding of cutoff errors.

Determination of the amount to seed into the financial accounts requires analysis of the materiality allocation scheme. For the income statement accounts, the overall materiality threshold is five percent of net income, or \$16.40. For balance sheet accounts,

TABLE 38  
**ACCOUNTS SEEDED WITH MONETARY ERRORS OF A MATERIAL AMOUNT RESULTING FROM A CUTOFF ERROR IN JANUARY**

Amount Seeded	Monthly Balances for Current Audit Period											
	Financial Accounts Seeded											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	Gross Sales											
-12.44	92	197	305	413	514	622	720	836	950	1,065	1,173	1,289
-12.44	89	197	300	409	516	616	723	831	937	1,050	1,163	1,277
-12.44	37	90	142	192	243	292	346	390	449	502	558	615
-12.44	12	40	67	92	118	145	171	198	224	252	283	315
-12.44	12	40	67	92	118	145	171	198	224	252	283	315
-12.44	320	326	326	326	327	327	327	324	326	327	327	326
-12.44	819	841	834	834	837	838	837	829	835	1,076	1,166	1,202
-12.44	103	103	103	103	103	103	103	103	103	1,063	1,171	1,290
-12.44	103	103	103	103	103	103	103	103	103	1,063	1,171	1,290
-12.44	53	53	53	53	53	53	53	53	53	515	515	515
-12.44	53	53	53	53	53	53	53	53	53	515	515	515
-12.44	341	338	338	338	338	340	340	336	339	340	337	339
-12.44	854	847	847	847	849	850	850	841	848	850	843	847
	Accounts Receivable											
-12.44	197	201	204	201	202	197	202	196	197	201	199	200
-12.44	307	312	314	309	324	308	310	306	319	319	314	310
-12.44	819	841	834	834	837	838	837	829	835	837	831	832
-12.44	214	214	214	214	215	210	215	209	210	214	212	213
-12.44	325	327	327	322	327	321	323	319	332	332	327	322
-12.44	854	854	847	847	849	850	850	841	848	850	843	847
	Cost of Sales											
-8.87	42	98	152	206	259	313	368	424	481	520	596	652
-8.87	21	111	160	213	264	316	367	419	470	523	579	630
-8.87	21	61	88	112	139	166	192	219	245	273	304	326
-8.87	229	350	347	347	346	349	349	345	348	346	346	347
-8.87	828	862	855	866	868	862	859	852	857	858	852	856
-8.87	103	107	161	205	256	322	377	432	462	515	571	628
-8.87	53	53	53	53	53	53	53	53	53	515	515	515
-8.87	53	53	53	53	53	53	53	53	53	515	515	515
-8.87	341	338	338	338	338	340	340	336	339	340	337	339
-8.87	854	847	847	847	849	850	850	841	848	850	843	847

the overall materiality threshold is five percent of total assets, or \$42.35. The materiality allocation scheme is based on the proportion of dollars within an account compared to the total dollars contained in all the accounts. For the income statement accounts, there are \$2,264.00 total dollars. This amount was derived by adding gross sales, cost of sales and administrative expenses. The total dollars in the balance sheet accounts are \$1694.00, derived by adding total assets and total liabilities and equity.

The simulation model actually aggregates the balances in each individual financial account to obtain the total dollar amount. The total dollar amount includes balances of both debit and credit accounts. The use of aggregated accounts in an actual financial statement, such as total assets, would not include both debit and credit balances in the total dollar amount. The total asset account adds the debits but subtracts the credits.

Allocation of the materiality threshold to the various accounts is as follows:

- a. Net Sales - \$12.38  
Square root of [  $(1290/2264) * (16.40*16.40)$  ]
- b. Gross Profit - \$8.64  
Square root of [  $(628/2264) * (16.40*16.40)$  ]
- c. Accounts Receivable - \$15.02  
Square root of [  $(213/1694) * (42.35*42.35)$  ]
- d. Gross Sales - \$12.44  
Square root of [  $(1302/2264) * (16.40*16.40)$  ]
- e. Cost of Sales - \$8.87  
Square root of [  $(662/2264) * 16.40*16.40$  ]
- f. Finished Goods Inventory - \$10.79  
Square root of [  $(110/1694) * (42.35*42.35)$  ].

When errors are seeded for an affected account set, the smallest materiality threshold of the two accounts is used as the amount of error for both accounts. The amount of error seeded into the two related accounts should be equal since it is assumed that the error was caused by the erroneous processing of a transaction. If different amounts were originally posted to the two related accounts, an out-of-balance situation would result. It is assumed that existing accounting control systems can detect and correct out-of-balance conditions.

The smaller of the account materiality thresholds is used since it is assumed that smaller errors are more difficult to detect than larger errors. Table 38 shows that the error seeding process functions correctly in the simulation model. The monetary error seeded into gross sales and accounts receivable was \$12.44, which is less than \$15.02. Likewise, \$8.87 was seeded into finished goods inventory and cost of sales, as opposed to \$10.79.

Table 39 presents the results of seeding cumulative errors of one-half a material amount at the end of each interim period. The accounts affected are the same as those listed in Table 38. However, the reversing process for the monetary error does not occur since the error is cumulative. The total monetary amount seeded into gross sales and accounts receivables is \$6.22 (one-half of \$12.44), with approximately \$1.55 seeded into March, June, September and December. The total amount for finished goods inventory and cost of sales is \$4.44, with one fourth seeded into March, June, September and December.

The above examples demonstrate that the simulation model does correctly seed monetary errors into the financial data sets for the specified conditions of error size and distribution. Although only two combinations of error size and distribution were demonstrated,

TABLE 39  
 ACCOUNTS SEEDED WITH MONETARY ERRORS OF ONE-HALF A MATERIAL AMOUNT  
 RESULTING FROM PERMANENT ERRORS AT THE END OF EACH INTERIM PERIOD

Amount Seeded	Financial Accounts Seeded	Monthly Balances for Current Audit Period											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		Gross Sales											
-1.55	Gross Sales	105	212	316	424	525	631	729	845	958	1,072	1,181	1,295
-1.55	Net Sales	102	210	311	420	522	628	732	840	945	1,050	1,171	1,282
-1.55	Gross Profit	50	102	153	203	254	304	355	407	457	510	566	621
-1.55	Operating Income	25	50	78	103	129	154	180	207	232	260	291	321
-1.55	Taxable Income	25	50	78	103	129	154	180	207	232	260	291	321
-1.55	Net Income	25	50	78	103	129	154	180	207	232	260	291	321
-1.55	Total Equity	332	341	337	337	338	337	337	333	324	322	332	332
-1.55	Total Liabilities & Equity	832	854	845	845	848	847	847	838	843	845	839	841
		Accounts Receivable											
-1.55	Accounts Receivable	310	214	215	212	212	206	211	205	205	209	207	206
-1.55	Current Assets	320	325	325	320	332	317	319	315	327	327	322	316
-1.55	Total Assets	832	854	845	845	848	847	847	838	843	845	839	841
		Finished Goods Inventory											
1.11	Finished Goods Inventory	110	111	111	109	123	113	110	112	125	121	118	114
1.11	Current Assets	320	325	326	321	336	320	322	318	330	330	325	321
1.11	Total Assets	832	854	846	846	849	849	849	840	846	849	842	845
		Cost of Sales											
-1.11	Cost of Sales	54	107	159	213	265	319	374	430	486	544	601	657
-1.11	Gross Profit	25	102	154	204	252	307	358	410	460	512	569	620
-1.11	Operating Income	25	92	179	241	293	357	422	482	539	602	664	720
-1.11	Taxable Income	25	92	179	241	293	357	422	482	539	602	664	720
-1.11	Net Income	25	92	179	241	293	357	422	482	539	602	664	720
-1.11	Total Equity	332	341	338	338	338	338	338	335	336	338	336	337
-1.11	Total Liabilities & Equity	832	854	846	846	849	849	849	840	846	849	842	845

it validates the logic of the model. Errors are seeded for the other thirty-four combinations by varying the input parameters to the error seeding process.

Application of Alternative  
Procedural Sets

Table 40 presents test results which validate the performance of the analytical procedures. The test is based on the seeded financial data summarized in Table 38. Three test cutoff points were evaluated: (a) a monthly cutoff where the month(s) seeded with the monetary errors are evaluated, (b) a September point-in-time cutoff which assumes that the auditor is performing interim tests, and (c) a December point-in-time cutoff where the cumulative financial statements are evaluated at the end of the current audit period.

Note that only those months which are seeded with a monetary error need be evaluated. If no errors are seeded into the financial accounts, the results of analyzing the procedure set will be same as the no-error evaluation.

For gross margin percentage, the actual ratio values are calculated for both the current and previous audit periods. Application of the numerator benchmark procedure predicts that the gross profit account balance for January should be \$43.80 (0.4891 \* \$89.56). The actual account balance in the current audit period is \$46.43, resulting in a difference of \$2.63. The comparison criteria is based on the prior knowledge that the entire monetary error occurs in a single month. Hence, the account materiality threshold of \$8.64 is used as the comparison criteria. Since the difference is less than a material amount, an investigation is not signalled.

TABLE 40  
SIMULATION TEST RESULTS

Analytical Procedure	Test Cutoff	Current Period	Previous Period	Difference Compared	Comparison Criteria	P-2	Investigation Signalled
Gross Margin Percentage							
Numerator Benchmark . . . . .	January-Non	.5184	.4991	2.6234	B.6381	---	No
	September-PIT	.4863	.4932	6.5611	6.4706	---	Yes
	December-PIT	.4868	.4925	7.3290	B.6381	---	No
Denominator Benchmark . . . . .	January-Non	.5184	.4891	5.3635	12.3803	---	No
	September-PIT	.4863	.4932	13.3425	9.2893	---	Yes
	December-PIT	.4868	.4925	14.8731	12.3803	---	Yes
10% Change . . . . .	January-Non	.5184	.4891	.0599	.1000	---	No
	September-PIT	.4863	.4932	.0140	.1000	---	No
	December-PIT	.4868	.4925	.0115	.1000	---	No
Regression . . . . .	January-Non	1.71	---	---	B.6381	B9	No
Net Sales							
Change Exceeds Material Amount . . . . .	January-Non	119.56	92.00	2.4378	12.3803	---	No
	September-PIT	950.00	898.00	62.0000	9.2893	---	Yes
	December-PIT	1200.00	1200.00	90.0000	12.3803	---	Yes
10% Change and Balance > 5% of PI	January-Non	119.56	92.00	.0265	.1000	---	No
	September-PIT	950.00	898.00	.0693	.1000	---	No
	December-PIT	1200.00	1200.00	.0790	.1000	---	No
10% Change as Percentage of CS . . . . .	January-Non	.0676	.0959	.0284	.1000	---	No
	September-PIT	.0865	.0941	.0077	.1000	---	No
	December-PIT	.0908	.0916	.0008	.1000	---	No
Time Series . . . . .	January-Non	16.13	---	---	12.3803	B9	Yes
Gross Profit							
Change Exceeds Material Amount . . . . .	January-Non	46.43	45.00	1.4310	B.6381	---	No
	September-PIT	462.00	431.00	24.0000	6.4706	---	Yes
	December-PIT	620.00	591.00	57.0000	B.6381	---	Yes
10% Change and Balance > 5% of PI	January-Non	46.43	45.00	.0318	.1000	---	No
	September-PIT	462.00	431.00	.0541	.1000	---	No
	December-PIT	620.00	591.00	.0626	.1000	---	No
10% Change as Percentage of CS . . . . .	January-Non	.0316	.0405	.0278	.1000	---	No
	September-PIT	.0798	.0841	.0090	.1000	---	No
	December-PIT	.0872	.0815	.0018	.1000	---	No
Time Series . . . . .	January-Non	7.11	---	---	B.6381	75	No

Applying the denominator benchmark procedure to the September test cutoff does signal an investigation. The expected value for net sales is \$936.74 ( $\$462/0.4932$ ). The actual balance for net sales in the current audit period is \$950.08, resulting in a difference of \$13.34. Since the September cutoff test is based on the cumulative account balances, the comparison criteria should also be cumulative. Point-in-time cutoff procedures assume that the errors occur evenly throughout the period. Thus, only nine-twelfths of the possible errors are in the financial balances by September, producing a comparison criteria of \$9.33. Since the difference equals or exceeds the comparison criteria, an investigation is signalled.

Evaluation of the ten percent change procedure for the monthly cutoff test indicates that an investigation is not signalled. The previous period ratio was 0.4891, while the current period ratio is 0.5184. This indicates a 5.99 percent increase in the ratio, which is less than the ten percent criteria.

Evaluation of the material change procedure for accounts receivable signals an investigation. The seeded account balance for accounts receivable in January of the current audit period is approximately \$197 (from Table 38). The previous months balance is approximately \$216 (from Table 37). This results in a current audit period difference of approximately \$-19. For the previous audit period, the difference is \$-1 (from Table 23, \$212 - \$213). The difference between the current and previous audit period is approximately \$18, which is greater than the account materiality threshold of \$15. Thus, an investigation is signalled.

Evaluating the yearly change procedure for gross profit does not signal an investigation. From Table 38, the current period balance for gross profit is \$46.43, while the previous period

balance from Table 37 is \$45. This represents a 3.18 percent increase in the account balance, which is less than the ten percent criteria. Had the difference exceeded the ten percent criteria, the balance in the current audit period would have to equal or exceed five percent of net income to signal an investigation.

The monthly change procedure for gross profit is identical to the ten percent change procedure applied to the gross margin percentage ratio. The ratio of gross profit to gross sales is evaluated for January of the current audit period and the previous month, December. An investigation is signalled if the difference in the ratios equals or exceeds ten percent.

Validation of the regression model for gross margin percentage is presented in Table 41. The dependent variable is gross profit, which is predicted from the independent variable of net sales. The Durbin-Watson test indicates no significant bias due to serial correlation in the residuals. Hence, no transformations of the data are required. To validate the computation of the upper precision limit, the following information is needed:

- a. The residual for January of the current audit period, \$1.6998, which is calculated from the predicted value of gross profit (\$44.73, derived from the intercept, 0.6309, plus the quantity of slope, 0.4924, times the value for net sales in January of the current audit period, \$89.56, (from Table 38)), and the book value of gross profit, \$46.43 (from Table 38).
- b. The standard error of the estimate ( $S_{xy}$ ), 1.5935, obtained from Table 41.
- c. The thirty-six month base period mean for net sales ( $\bar{X}$ ), \$90.1667, and the sum of the squared values of net sales ( $\sum X^2$ ), \$296,446.
- d. The book value for net sales in January of the current

TABLE 41  
REGRESSION OF GROSS PROFIT ON NET SALES

Regression Statistics

R <sup>2</sup> . . . . .	.9136
R <sup>2</sup> (Adjusted) . . . . .	.9110
Standard Error of Estimate	1.5935

Test of Residuals

Ho: Residuals are Random  
Z = 1.7152 p-value is .0863  
Not Reject

Durbin-Watson Test for autocorrelation

Model is  $e[t] = p * e[t-1] + v[t]$   
Estimate of p is -.00199446  
Ho: p = 0  
Test Statistic is 3.2516942  
1 regressors and size 36  
Approximate results are: Not Reject

Coefficient Statistics

	Estimate	Std. Error	Lower Bnd	Upper Bnd	Ho: Bi=0 t-value
B0	.6309	-----	-----	-----	-----
B1	.4924	.0260	.4394	.5454	18.9605

TABLE 41 - Continued.

Data Values				
Month	Gross Prof	Net Sales	$E\{y\}$	Residuals
1	33.0000	64.0000	32.1436	.8564
2	38.0000	74.0000	37.0674	.9326
3	38.0000	75.0000	37.5598	.4402
4	33.0000	71.0000	35.5903	-2.5903
5	40.0000	77.0000	38.5446	1.4554
6	37.0000	76.0000	38.0522	-1.0522
7	41.0000	82.0000	41.0065	-.0065
8	43.0000	84.0000	41.9913	1.0087
9	41.0000	85.0000	42.4837	-1.4837
10	40.0000	84.0000	41.9913	-1.9913
11	41.0000	83.0000	41.4989	-.4989
12	44.0000	87.0000	43.4685	.5315
13	38.0000	83.0000	41.4989	-3.4989
14	47.0000	92.0000	45.9304	1.0696
15	47.0000	95.0000	47.4075	-.4075
16	47.0000	90.0000	44.9456	2.0544
17	47.0000	91.0000	45.4380	1.5620
18	48.0000	89.0000	44.4532	3.5468
19	45.0000	91.0000	45.4380	-.4380
20	49.0000	95.0000	47.4075	1.5925
21	45.0000	91.0000	45.4380	-.4380
22	49.0000	96.0000	47.8999	1.1001
23	51.0000	96.0000	47.8999	3.1001
24	48.0000	95.0000	47.4075	.5925
25	45.0000	92.0000	45.9304	-.9304
26	49.0000	96.0000	47.8999	1.1001
27	45.0000	96.0000	47.8999	-2.8999
28	47.0000	96.0000	47.8999	-.8999
29	47.0000	96.0000	47.8999	-.8999
30	50.0000	101.0000	50.3619	-.3619
31	51.0000	99.0000	49.3771	1.6229
32	51.0000	104.0000	51.8390	-.8390
33	53.0000	108.0000	53.8086	-.8086
34	52.0000	104.0000	51.8390	.1610
35	50.0000	103.0000	51.3466	-1.3466
36	51.0000	105.0000	52.3314	-1.3314
Number	36	36		
Means	45.0278	90.1667	45.0277	.0001
Std Dev	5.3425	10.3717	5.1069	1.5691

audit period ( $X_t$ ), \$89.56.

e. The standard deviation of the residual, 0.0307, which is derived from the information in b, c, and d above using the following formula:

$$S_{xy} * \text{SQRT} \left\{ \left[ 1 + \frac{1}{36} + (X_t - \bar{X}')^2 \right] / \left[ \sum X'^2 - (\sum X')^2 / 36 \right] \right\}$$

which equals  $1.5935 * 0.0193$ .

The upper precision limit is computed as the residual, plus the Student's t value corresponding to the desired reliability level times the standard deviation of the residual. For a risk level of 0.36 and 34 degrees of freedom, the Student's t value is approximately 0.3614. For the test data provided, the upper precision limit equals \$1.71. Since this amount is less than the comparison criteria, an investigation is not signalled.

Table 42 presents the results of applying a simple linear model as a time series of net sales. The predicted value for net sales in January of the current audit period is \$107.37. The actual value for net sales found in Table 38 is \$89.56, producing a residual of 17.81. The standard deviation of the residual evaluates to 1.028, resulting in an upper precision limit of \$18.13. An investigation is signalled since the upper precision limit equals or exceeds the monthly account materiality threshold.

Although Table 42 indicates that serial correlation is not a problem for this model, the regression results will be used as a basis to validate the operation of the Cochrane-Orcutt transformation. Both the dependent and independent variables are adjusted with the following formula:<sup>1</sup>

---

<sup>1</sup>Rao and Griliches, pp. 255-256.

TABLE 42  
TIME SERIES OF NET SALES

Regression Statistics

R <sup>2</sup> . . . . .	.8920
R <sup>2</sup> (Adjusted) . . . . .	.8888
Standard Error of Estimate	3.4590

Test of Residuals

Ho: Residuals are Random  
Z = -.6090 p-value is .5425  
Not Reject

Durbin-Watson Test for autocorrelation

Model is  $e[t] = p * e[t-1] + v[t]$   
Estimate of p is .28641733  
Ho: p = 0  
Test Statistic is 1.1823917  
1 regressors and size 36  
Approximate results are: Reject

Coefficient Statistics

	Estimate	Std. Error	Lower Bnd	Upper Bnd	Ho: Bi=0 t-value
B0	72.9667	-----	-----	-----	-----
B1	.9297	.0555	.8164	1.0431	16.7533

TABLE 42 - Continued.

Data Values				
Month	Net Sales	Time Serie	E{y}	Residuals
1	64.0000	1.0000	73.8964	-9.8964
2	74.0000	2.0000	74.8261	-.8261
3	75.0000	3.0000	75.7559	-.7559
4	71.0000	4.0000	76.6856	-5.6856
5	77.0000	5.0000	77.6153	-.6153
6	76.0000	6.0000	78.5451	-2.5451
7	82.0000	7.0000	79.4748	2.5252
8	84.0000	8.0000	80.4045	3.5955
9	85.0000	9.0000	81.3342	3.6658
10	84.0000	10.0000	82.2640	1.7360
11	83.0000	11.0000	83.1937	-.1937
12	87.0000	12.0000	84.1234	2.8766
13	83.0000	13.0000	85.0532	-2.0532
14	92.0000	14.0000	85.9829	6.0171
15	95.0000	15.0000	86.9126	8.0874
16	90.0000	16.0000	87.8423	2.1577
17	91.0000	17.0000	88.7721	2.2279
18	89.0000	18.0000	89.7018	-.7018
19	91.0000	19.0000	90.6315	.3685
20	95.0000	20.0000	91.5613	3.4387
21	91.0000	21.0000	92.4910	-1.4910
22	96.0000	22.0000	93.4207	2.5793
23	96.0000	23.0000	94.3505	1.6495
24	95.0000	24.0000	95.2802	-.2802
25	92.0000	25.0000	96.2099	-4.2099
26	96.0000	26.0000	97.1396	-1.1396
27	96.0000	27.0000	98.0694	-2.0694
28	96.0000	28.0000	98.9991	-2.9991
29	96.0000	29.0000	99.9288	-3.9288
30	101.0000	30.0000	100.8586	.1414
31	99.0000	31.0000	101.7883	-2.7883
32	104.0000	32.0000	102.7180	1.2820
33	108.0000	33.0000	103.6478	4.3523
34	104.0000	34.0000	104.5775	-.5775
35	103.0000	35.0000	105.5072	-2.5072
36	105.0000	36.0000	106.4369	-1.4369
Number	36	36		
Means	90.1667	18.5000	90.1667	-.0000
Std Dev	10.3717	10.5357	9.7953	3.4093

$$V(i) = V(i) - [ V(i-1) * p ]$$

An estimate of  $p$ , the correction factor, is used to adjust both net sales and the time series variable. ( $p$  is obtained from Table 42) Applying the above formula, the adjusted time series variable for month 36 equals  $36 - (35 * 0.2865)$ . The adjusted values for net sales and the time series independent variable are presented in Table 43. These adjusted values are used as input to the regression model, with the results also presented in Table 43.

The estimators of the adjusted model are then used to predict the values of the dependent variable. The adjusted time series value for month 37 (January of the current audit period) is 26.689. Using this value as the independent variable, the predicted net sales value for January is 75.817. But this value is not  $Y(i)$ . It is  $Y(i) - [ Y(i-1) * p ]$ . Thus, the transformation process must be reversed to produce a predicted monthly balance for January that is expressed in the same units as the comparison criteria. The predicted monthly balance for net sales in January of the current audit period becomes \$105.89.

TABLE 43  
COCHRANE-ORCUTT TRANSFORMATION APPLIED TO NET SALES

Regression Statistics

R <sup>2</sup> . . . . .	.8085
R <sup>2</sup> (Adjusted) . . . . .	.8028
Standard Error of Estimate	3.0141

Test of Residuals

Ho: Residuals are Random  
Z = 1.3528 p-value is .1761  
Not Reject

Durbin-Watson Test for autocorrelation

Model is  $e[t] = p * e[t-1] + v[t]$   
Estimate of p is .01526143  
Ho: p = 0  
Test Statistic is 1.8369894  
1 regressors and size 36  
Approximate results are: Not Reject

Coefficient Statistics

	Estimate	Std. Error	Lower Bnd	Upper Bnd	Ho: Bi=0 t-value
B0	54.1562	-----	-----	-----	-----
B1	.8116	.0677	.6733	.9500	11.9801

TABLE 43 - Continued.

## Data Values

Month	Adj. Net S	Adj. Time	E{y}	Residuals
1	61.3187	.9581	54.9338	6.3849
2	55.6693	1.7136	55.5470	.1223
3	53.8051	2.4272	56.1261	-2.3210
4	49.5187	3.1407	56.7053	-7.1866
5	56.6644	3.8543	57.2845	-.6201
6	53.9459	4.5679	57.8636	-3.9178
7	60.2323	5.2815	58.4428	1.7895
8	60.5138	5.9951	59.0220	1.4918
9	60.9409	6.7087	59.6011	1.3398
10	59.6545	7.4222	60.1803	-.5258
11	58.9409	8.1358	60.7595	-1.8185
12	63.2274	8.8494	61.3386	1.8887
13	58.0817	9.5630	61.9178	-3.8361
14	68.2274	10.2766	62.4970	5.7304
15	68.6496	10.9902	63.0761	5.5735
16	62.7904	11.7037	63.6553	-.8650
17	65.2224	12.4173	64.2345	.9880
18	52.9360	13.1309	64.8136	-1.8776
19	65.5089	13.8445	65.3928	.1160
20	68.9360	14.5581	65.9720	2.9640
21	63.7904	15.2717	66.5511	-2.7608
22	69.9360	15.9852	67.1303	2.8057
23	68.5039	16.6988	67.7095	.7945
24	67.5039	17.4124	68.2887	-.7847
25	64.7904	18.1260	68.8678	-4.0775
26	69.6496	18.8396	69.4470	.2026
27	68.5039	19.5532	70.0262	-1.5222
28	68.5039	20.2667	70.6053	-2.1014
29	68.5039	20.9803	71.1845	-2.6806
30	73.5039	21.6939	71.7637	1.7403
31	70.0719	22.4075	72.3428	-2.2710
32	75.6447	23.1211	72.9220	2.7227
33	78.2126	23.8346	73.5012	4.7114
34	73.0669	24.5482	74.0803	-1.0134
35	73.2126	25.2618	74.6595	-1.4469
36	75.4990	25.9754	75.2387	.2604
Number	36	36		
Means	65.1023	13.4865	65.1023	-.0000
Std Dev	6.7881	7.5201	6.1035	2.9708

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